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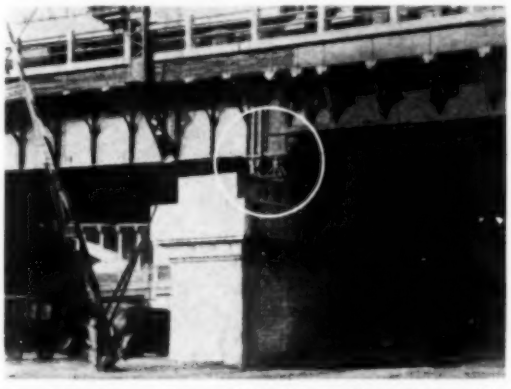
Castings Carry the Weight of Heavy Bridge Loads

THUNDERING over highways of steel, huge locomotives carry the fuel and food of a nation and form a linkage of all the vital forces that support our national being. Since the first crude railroads were built, the



Steel Castings Support Bridges That Carry the Transportation Facilities of the Country

trend has been toward heavier and more powerful locomotives to pull longer trains and greater loads. A study of the economic problems of transportation in the United States shows the progress made in adapting the equipment to keep step with the developments of industry. This increase in the weight of rolling stock to cut the cost of transportation per train mile has necessitated more careful engineering and better and better materials to carry the loads. Through all this progress the art of the molder has played an important part. Not only in locomotives and cars but also in the construction of the bridges, the use of castings is a necessary element. Live loads, sudden shock, and the corrosive action of steam and gases must be resisted by the materials that make up the structure of the bridge. When stresses of the modern railroad bridge are traced they lead to castings holding the beams above the abutments.

Find Where Castings Can Be Sold

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Heat Treating Light Gray Iron Castings

Difficulties

By

WHILE the heat treatment of gray iron castings is not new, the possibilities of using that method to provide or enhance certain physical properties of the material are receiving considerable attention at the present time. One application of heat treatment to gray iron is to satisfy a demand from many manufacturing establishments for castings which may be machined at the highest possible speeds. The method is particularly applicable in jobbing foundries which, of necessity, produce a wide variety of castings in varying tonnages in which it would be difficult to vary the iron charges to accommodate each type.

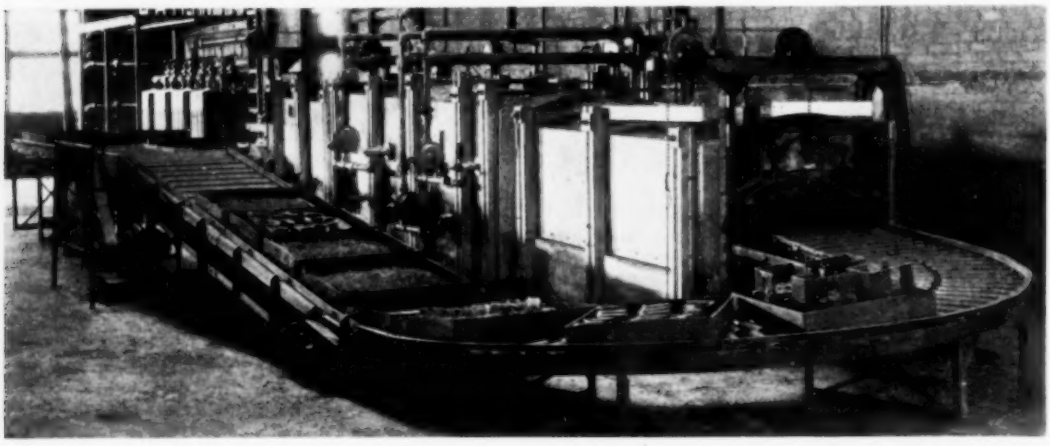
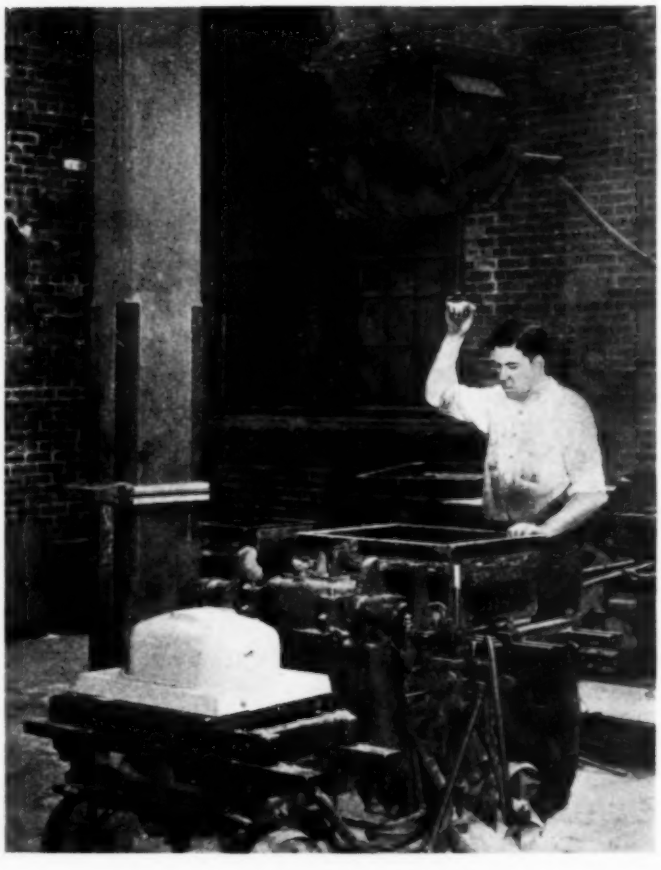


Fig. 1—(Left) — An Automatic Continuous Heat Treating Oven Has Reduced the Time for That Operation. Fig. 2—(Below) — Overhead Sand Hoppers Supply Material for Making Some of the Heavy Cores

One jobbing foundry which employs heat treatment to obtain easy machinability in its light castings is the Brown & Sharpe Mfg. Co., Providence, R. I. Due to its ability to supply castings possessing that characteristic, the firm is able to sell them at a premium which makes the operation profitable. The company feels that heat treatment should be a part of a modern jobbing foundry's service, and that it should be suggested to the customers where the foundry's engineers feel that the results attained will help in subsequent machining operations.



Heat treatment as practiced by Brown & Sharpe Mfg. Co. should not be confused with aging or seasoning in which the castings are treated at 900 degrees Fahr. That treatment does not change the structure to any appreciable extent. The method employed by the firm is such that graphite to a large extent replaces the combined carbon. The entire process takes about 2 hours, and occurs in three stages or cycles which include a heating up period, exposure to high temperature, and a cooling period. The heat treatment process fills an important need, and is arranged so that it becomes a routine operation in the production

Iron Castings Decreases *in Machining*

H. R. Simonds

of easily machined, light, gray iron castings.

A typical jobbing foundry differs from a production foundry in many essential features. Some of these are: Greater diversity in size of work, greater number of short run orders and more difficulty with pattern equipment. The latter difference is based on the frequent necessity of using customer-designed patterns unsuitable to local foundry conditions. The pattern usually furnishes the first contact between the jobbing foundry and its customers, and at the recently revamped jobbing foundry of the Brown & Sharpe Mfg. Co. unusual significance is given to the proper pattern equipment and to its care at the foundry.

Experience has shown that an improvement in castings and a reduction in cost of work usually may be secured through alterations in pattern equipment. When new work is to be estimated from patterns submitted, a conference is held between representatives of the foundry and the pattern shop, and from this conference two estimates are usually prepared, one based on the use of the patterns submitted and the other based on the use of redesigned patterns which it is thought will be better suited to production.

Even when the number of pieces called for is relatively small, the foundry manager has found it advantageous to put the pattern on a plate or to mount it with support for use on a vibrating frame. Some of the simple methods of supporting patterns are shown in Fig. 6. For both plates and frame supports, standard parts are used wherever possible. For the patterns supported as depicted in the illustration, the cost of mounting is low and usually

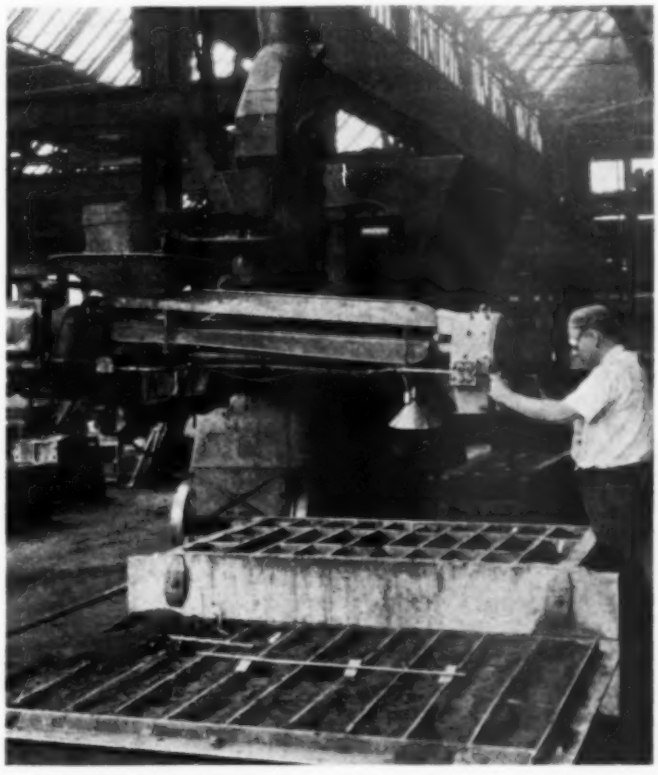


Fig. 5—A Sand Slinging Machine Travels on Rails

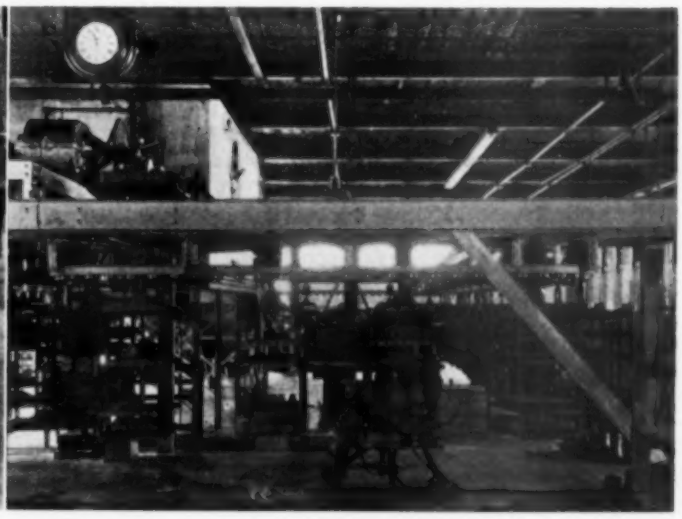


Fig. 3—(Left)—Trucks Convey Molten Metal to the Heavy Molding Floors. Fig. 4—(Right)—View of the Light Core Room Showing the Continuous Conveyor

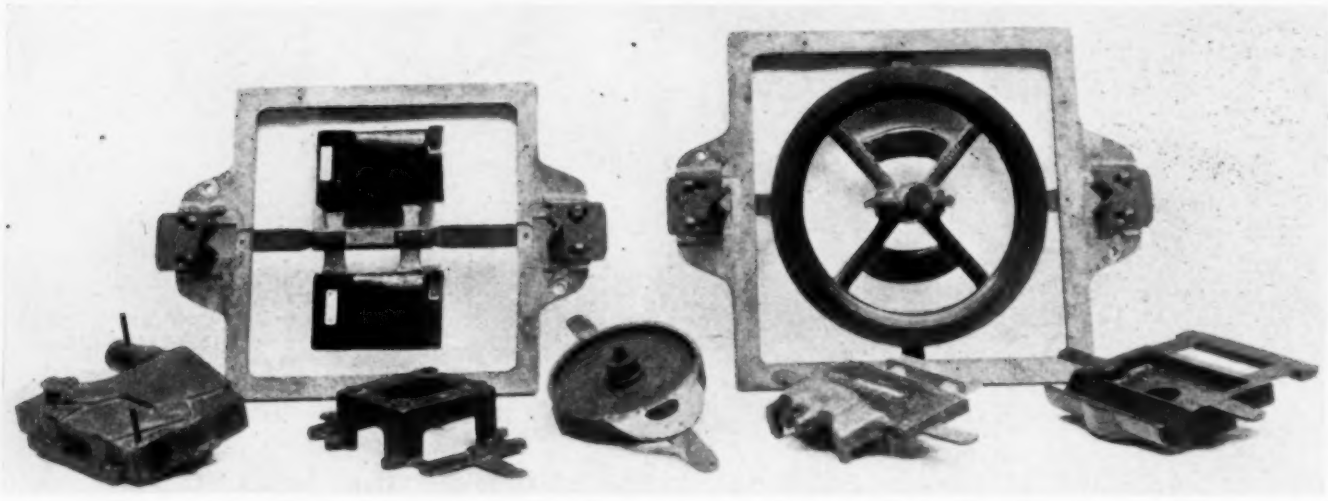


Fig. 6—Labor Cost Is Reduced by Rigging the Patterns for Squeezer Production Wherever Possible

offset by reduced labor cost with a run of half a dozen molds or more. In addition the quality of the work is usually better on a machine molded job.

It is always difficult to change pattern equipment and sometimes the firm has found it necessary to make up sample castings in accordance with the new design and submit these for approval. When the design has been decided upon definitely and the pattern equipment has been received or completed it is marked carefully with a file number and a descriptive record is entered in the file clerk's books. From this record the pattern may be located at any future time even though the order number has been lost.

Standardized Colors Used

The colors for pattern and core prints have been standardized so that a molder knows at a glance the general characteristics of each part. Instead of the usual shellac the pattern department has found that quick drying lacquer is easy to apply and gives a smooth surface for contact with sand. The company has standardized on aluminum match plates.

A classification of all work is made according to size, and the small work is kept separate from the large through the molding, pouring and cleaning operations. A portion of the molding floor in the small work division is shown in Fig. 7. Ample space is an important feature here. Before alteration the molding floor was crowded and that condition was found to have a psychological effect in slowing down the pace to suit the space.

Actual work on an order for castings starts in the usual way with a work order which is made out in multiple so that the different departments concerned are notified simultaneously. The copy sent to the pattern storage department becomes the instruction for collecting and delivering pattern equipment to the proper place on the foundry floor. In a similar way the core room foreman receives his instruction for delivery of cores to the molding floor. On most of the work the cores are supplied direct to the molder although on some production jobs a separate gang places cores and closes molds.

Several different types of molding machines and several methods of conveying the sand to the machine are used. Fig. 5 shows a sand slinging machine which is used for much of the large work. The machine travels back and forth on rails placed flush with the concrete floor of the foundry. The machine receives its power from an overhead trolley of special construction to avoid interference with the traveling cranes. The trolley may be seen in the upper portion of the illustration. Another method of receiving sand for molding is shown in Fig. 2 and a third method is in the delivery of sand to the molding machine by small electric trucks. A large jolt roll over core machine is shown in Fig. 10. The machine is provided with a roller conveyor and is equipped for rapid change of core boxes.

Machines Are Redesigned

Many of the molding machines and much of the other equipment have been altered slightly or redesigned to fit the actual conditions better. The machine in Fig. 10 has been provided with special bed rails so that different sizes of core boxes may be used by simply adjusting two bolts. The type of adjustable bar used may be seen at the left.

Much attention has been paid to the proper conditioning of molding sand. A section of the plant for heavy foundry work close to the

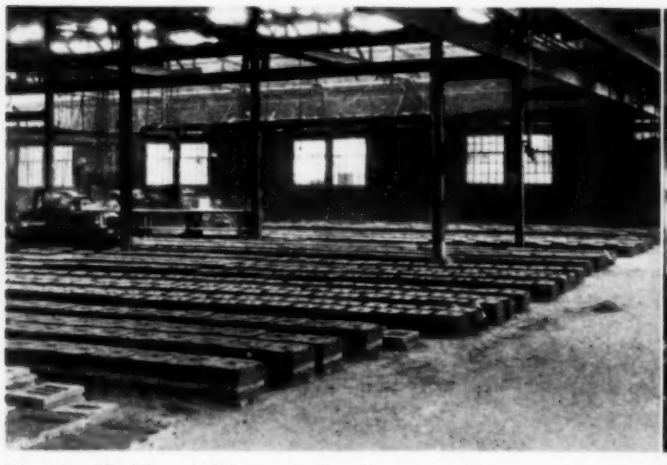


Fig. 7—(Left)—A View of the Squeezer Floors. Fig. 8—(Right)—Spiral Gravity Conveyor Carries the Castings from the Floor Above to the Cleaning Room

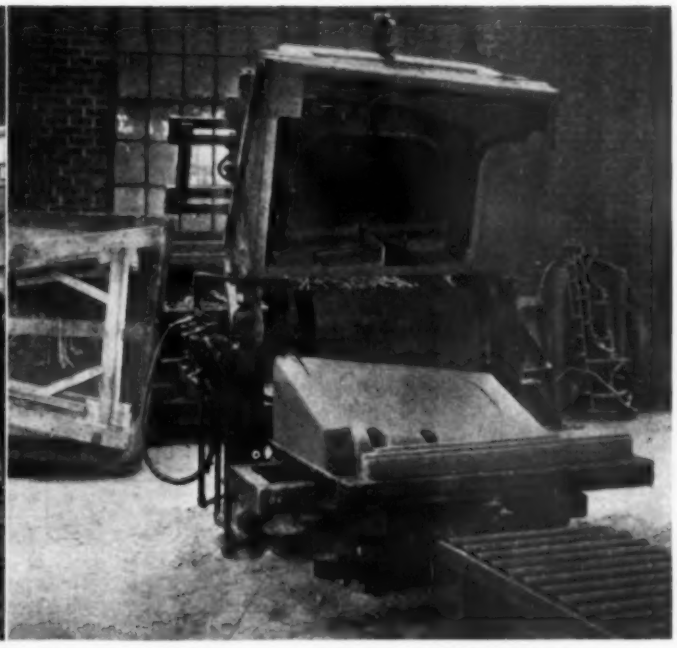


Fig. 9—(Left)—Entrance to the Continuous Baking Oven. Fig. 10—(Right)—Jolt Rollover Molding Machines Are Used for Large Cores Used in Some of the Heavy Castings

molding floor has been set aside for sand conditioning and each night all the sand for use in that department the following day is collected in that place. It is cut and mixed thoroughly with new sand and water as required to bring it to the proper condition. Experience has shown the firm that accurate control of moisture in the sand mixtures reduces losses greatly.

One of the important improvements in the light foundry operation has been the standardization of flasks. Wherever possible steel flasks of similar design, even though varying in size, are used. Pin sizes and pin centers also have been standardized and the variations have been reduced greatly. In a jobbing foundry where orders for the same piece are likely to be small, the advantage of having a flask small enough to give a minimum of excess backing sand is lessened and is frequently offset by the other advantage of uniform size of flasks used in the shop.

Molding machines also have been standardized wherever possible. For the small casting floor a straddle type of jolt squeeze traveling molding machine has been adopted. These machines straddle the piles of sand which extend the full length of the floors. The sand is picked up as the machines move from one end to the other, leaving in their wake the rows of completed molds. Each machine is supplied with air and electricity from overhead hose and trolley. With that general arangement with average size molds each molder is expected to get a high production each day.

Process Is Reversed

The method of developing molding speed at the Brown & Sharpe foundry is somewhat unusual. The usual practice employed in many foundries is first to break in a man to be a careful, painstaking molder and afterward to attempt to increase his speed. The manager of the Browne & Sharpe jobbing foundry has adopted the opposite method. He first secures speed even though more castings than usual are scrapped, and then gradually brings the quality up to the required standard.

Another interesting feature is the frequent shifting of men to other jobs. If a molder slows down below what is considered a profitable rate he is not laid off but is shifted to another job. Perhaps he is put on the pouring gang, the clean-up squad or it may be that he is transferred to the heat treating or annealing department. Pouring is an important job and realizing this the management has selected the pouring gang with considerable care. To be a good pourer a man should have a thorough working knowledge of molding and therefore a retired molder often makes an excellent man for the pouring gang.

Furthermore it frequently happens that a man's slackening in pace is only temporary. Perhaps it is due to domestic worries or some other cause. At any rate it often occurs that a

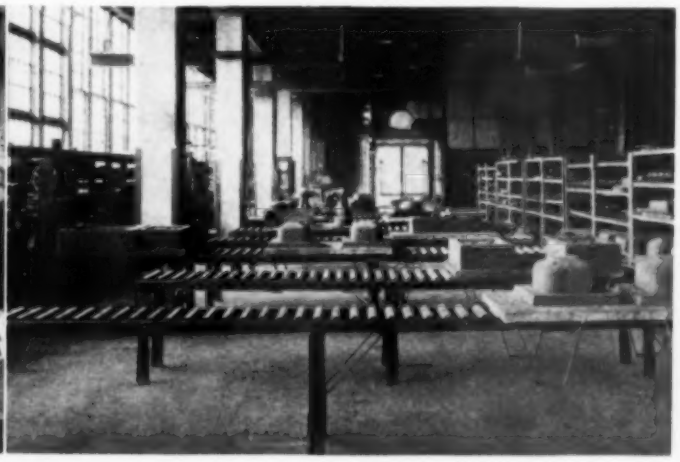


Fig. 11—(Left)—Grinding and Filing Section of the Cleaning Room. Fig. 12—(Right)—After Baking the Cores Are Placed on Roller Conveyors for Inspection

molder who has been shifted because of too slow work can be returned to successful molding after two or three months spent at a different job. This scheme of shifting molders to other jobs helps the management maintain a large force of skilled men which means greater flexibility and more rapid expansion of personnel when business conditions improve.

Cores are made both by hand and machine in a light, clean and well equipped core room. A section of the heavy core room shown in Fig. 12 illustrates the extensive use of conveyors. Extruding machines are used for cylindrical stock cores and grinding wheels conveniently located are used for squaring, tapering and finishing cores. The cores are placed on rack conveyors of a continuous core oven for baking. One part of this oven is shown in Fig. 9. The travel of the racks through the oven is so smooth that even slender cores may safely be put on end as shown in the illustration. Another view of the conveyor with the oven in the background is shown in Fig. 4.

One of the common difficulties with pattern equipment is the design of gates. The Brown & Sharpe company has found it advisable to give careful consideration to this feature. Difficult jobs have been produced successfully at the Brown & Sharpe foundry by the scientific designing of gates. Wherever feasible bottom pour gates are used and occasionally to prevent erosion of green sand molds, dry sand impact surfaces are employed. Screens and dams are more usual expedients.

Analysis Is Checked

Iron is melted in a 60-inch cupola which is tapped into a mixing ladle as shown in Fig. 3. A careful check on ladle analysis is provided by daily reports on test bars. The iron must meet a drill test for machinability as well as the usual brinell and fracture tests. The method of transporting molten iron is interesting. A large ladle set on a special angle iron support receives the iron from the mixing ladle. The ladle with its support is picked up by a lift truck and carried to the pouring floor. Steel strap bails are attached to each ladle so that they may be carried by crane when necessary.

Large molds are poured direct from the large ladles. Small molds are poured from hand ladles which in turn are filled from large ladles set down by the lift truck at convenient points. Tho special ladle support is mounted on casters as shown in Fig. 3. A smooth concrete floor which is kept in constant repair, throughout the foundry makes it possible to move the ladle supports by hand for short distances.

Heat treatment or annealing of light castings has been reduced greatly by the installation of a gas-fired, continuous annealing oven. Castings with the sand still on them are conveyed from the shakeout to the oven where they are placed on large flat trays, and covered with coke dust. The arrangement of the oven and conveyor is shown in Fig. 1. The oven is divided into three sections which are maintained at different temperatures. The first is a preheating chamber in which the castings are raised to 900 degrees Fahr. From that chamber the castings are conveyed into the next in which they are exposed to the maximum temperature of 1600 degrees Fahr. The third section is a cooling chamber where the castings are held until the temperature drops to about 600 degrees Fahr.

Castings Are Cooled

When that temperature is attained the castings are removed from the oven to the air and allowed to cool. Experience has shown that although the castings are taken out at 600 degrees Fahr., no ill effects such as surface hardening, scaling or cracking occur. Thin odd-shaped castings sometimes have to be packed in trays or wired together to prevent warping. The heat treatment process occupies about 2 hours compared with 24 to 36 hours with the old style of pot furnace. When the new oven first was placed in operation, considerable difficulty was experienced because of the carburizing effect of the gas atmosphere. However, a little experimenting developed the use of a coke dust covering which eliminates that trouble.

From the heat treating department the castings travel on a spiral gravity conveyor to the cleaning department on the floor below. The conveyor is shown in Fig. 8 which includes the conveyor system used in distributing castings for the various cleaning operations. Conveyors also are used to transport the castings through the finishing operations to the final boxing and shopping section.

Fig. 11 shows part of the cleaning department. The long row of grinders with exhaust piping is at the right, and the transfer conveyor at the extreme left. The inspection and file benches are placed parallel to the transfer conveyor, but on the side toward the grinders so that the castings in process may be held up for filing and inspection, or allowed to pass through to the transfer conveyor as conditions may dictate.

Boxes used for transporting the castings on the conveyor system have steel bottoms to minimize vibration and reduce friction. Some of the boxes are all steel and the firm is changing over to that type of box. Each box as it goes through the finishing department contains a ticket which describes the nature of the work, and gives tho work order number. After cleaning the castings are given a final inspection, and given a coat of paint.

New England Founders Elect Officers

The annual meeting celebrating the thirty-fifth anniversary of the New England Foundrymen's association was held Jan. 14 at the Engineers club, Boston. Eighty-six members were present at the meeting which was presided over by President Ernest F. Stockwell. Following the regular business meeting, the president reported the death of George A. Ray, Taylor & Fenn Mfg. Co., Hartford, Conn., a past president of the association. A committee consisting of Carl S. Neumann, Union Mfg. Co., New Britain, Conn., chairman; Henry F. Miller, Universal Winding Co., Providence, R. I.; and C. E. Andrews, Whitehead Bros, Co., Providence, R. I., was appointed to draft a set of suitable resolutions concerning the death of Mr. Ray.

Following the report of the secretary and treasurer, the nominating committee submitted a list of nominations for the ensuing year. The following officers were elected unanimously: Luther J. Anthony, Glenwood Range Co., Taunton, Mass., president; Leroy M. Sherwin, Brown & Sharpe Mfg. Co., Providence, R. I., vice president; Fred F. Stockwell, Barbour-Stockwell Co., Cambridge, Mass., secretary; and George H. Gibby, Gibby Foundry Co., East Boston, Mass., treasurer. Members of the executive committee include Warren D. Kent, Grinnell Co., Providence, R. I.; Albert Sweet, Milford Iron Foundry, Milford, Mass.; Fred. D. Shaw, Walker-Pratt Mfg. Co., Watertown, Mass.; Ralph R. Meigs, General Electric Co., Everett, Mass.; and C. A. Reed, Rogers Brown & Crocker Bros. Co., Boston.

The retiring president introduced the newly elected officers and thanked the members for their support during the past year. Past President E. F. Harrington, Hunt-Spiller Mfg. Corp., Boston, then presented Fred F. Stockwell with a radio in behalf of the past presidents, members and the association in recognition of the 35 years service as secretary of the group and as a token of esteem. After a few fitting words by the secretary, retiring president and the newly elected president, the meeting was devoted to entertainment.

Study Light Metals

The thirty-sixth general meeting of the Deutsche Bunsen Gesellschaft fuer Angewandte Physikalische Chemie, will be held in Vienna, May 25 to 27. The subject of the symposium will be "Recent Progress in the Science of Metallurgy with Particular Reference to Light Metals." Arrangements for the meeting are under the direction of Dr. Specketer, I. G. Farbenindustrie Aktiengesellschaft, Frankfurt-am-Main, Germany

Gun Metal Strength Is Affected by Phosphorus

By H. C. Dews

ALTHOUGH the effect of several impurities, such as lead, arsenic, and antimony in particular, and other metals in less detail, upon the properties of admiralty gunmetal have been investigated, the effect of phosphorus appears to have received little attention. Nevertheless, prolific data in relation to the effect of phosphorus on the pure bronzes frequently have been published.

Zinc-bronzes of which admiralty gunmetal is the best-known example, exhibit several different properties and serve different purposes in practice from the phosphor-bronzes, and the effect of phosphorus upon the two types of alloys is not in all respects similar. The amount of phosphorus, too, which is added to gunmetal is much less than is generally found in phosphor-bronze. It appears, then, that some report upon the effects of phosphorus on gunmetal should now be available.

Promotes Ease of Casting

The practice of adding a small amount of phosphorus to the melt during the preparation of gunmetal is in use in many foundries, and the opinion is well supported among foundrymen that greater facility in producing sound castings is obtained thereby. The manner in which the phosphorus functions and its effect upon physical properties is less understood. Indeed, there are such acute differences of opinion among metallurgists on this point that adequate enlightenment does not appear possible until many more experiments have been carried out both on a practical scale and of the type that can only be performed properly in a well-equipped research laboratory.

In this article no attempt is made to discuss the chemical or physical action of phosphorus on molten bronze. The results given here are concerned solely with the ultimate effect of phosphorus on those mechanical properties of the solid alloy with which commercial producers of castings chiefly are concerned.

Purchaser Interested in Properties

Admiralty gunmetal castings generally are accepted or rejected by the purchaser upon the results of tensile tests giving merely maximum stress and elongation figures. This test, therefore, has been chosen by which to follow the effect of phosphorus additions. The brinell hardness and density figures have been included as a matter of interest, because these data are understood widely and because of the possible use of the figures in discussing other aspects of the metallurgy or foundry practice of bronze.

All the experiments described were carried out under actual foundry conditions and with commercial

Describes Effects

ADDITIONS of small amounts of phosphorus during the preparation of admiralty gun metal, or the 88-10-2 alloy as it is known in the United States, is practiced in many foundries. It is believed that such additions promote sound castings. However, little has been published on the effect of phosphorus on the alloy in question, and the author has carried out some investigational work on the subject. His work shows that between 0.04 and 0.07 per cent phosphorus, there is a sharp reduction of tensile strength; brinell hardness increases up to the addition of 0.04 per cent and then decreases; density decreases as the phosphorus is increased from 0.06 to 0.13 per cent. The author is metallurgist for Dewrance & Co., London, and this article is abstracted from a paper presented at the September, 1930, meeting of the Institute of Metals, Southampton.

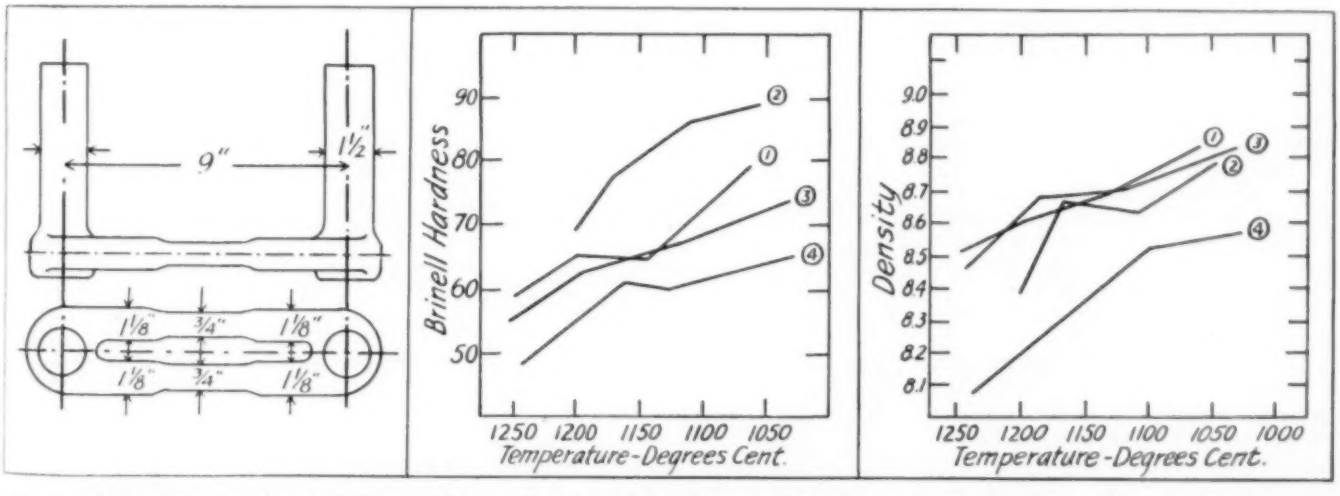


Fig. 1—Dimensions of the Test Bars. Fig. 2—Effect of Phosphorus and Casting Temperature on the Brinell Hardness. Fig. 3—Density Is Affected by Phosphorus and Casting Temperature

Compositions of Test Specimens

Alloy No.	1	2	3	4	0
Element	Per Cent	Per Cent	Per Cent	Per Cent	Per Cent
Phosphorus	0.002	0.043	0.065	0.131	0.002
Tin	10.08	9.82	9.94	9.84	9.89
Copper	87.5	87.4	87.3	87.1	87.3
Zinc	1.89	2.04	2.13	2.39	2.24
Lead	0.46	0.47	0.50	0.48	0.43
Arsenic	.....	0.053	0.048	.....	.....
Antimony	.....	0.020	0.030	.....	.....
Sulphur	.....	0.014	0.017	.....	.....

materials. The alloys were made up from ingot copper, Straits tin, spelter, soft lead, and commercial 10 per cent phosphor-copper. No scrap or ingot metal was used in any of the charges.

The metal was melted in 100-pound charges in crucibles in a coke-fired pit-type furnace working by natural draft. The copper was first charged and melted, and then the zinc, phosphor-copper, lead and tin added. The melts were ready for casting within 1 hour from the beginning of charging.

Four molds, each containing two test-bars, were poured from each heat of metal. The molds were machine made to insure regularity, and were cast green. The design of the pattern is shown in Fig. 1.

Pyrometer Was Used

Casting temperature of the metal was taken in the crucible immediately prior to pouring each mold. The pyrometer used was of the base-metal thermocouple type, recording on a portable millivoltmeter calibrated directly in degrees Cent. The bare ends of the thermocouple wires were exposed to the molten metal, but the rest of the couple was covered with refractory cement, and in taking temperatures the refractory insulation was plunged well below the surface of the melt.

Test-bars were turned to 0.564 inch diameter along the central 3 inch length, and the 1-inch length at each end was threaded for gripping in screw shackles. Elongation was measured on a 2-inch gage length. Maximum stress shown by two bars cast in the same mold differed in some cases, especially in those bars cast at low temperatures, by up to 4500 pounds per square inch. All the figures recorded refer to bars of each pair showing higher strength. After the bars were broken the screwed ends of the better bar of each pair were cut off and used for density and brinell hardness determinations.

Composition of all the heats was intended to be as near as possible to standard admiralty gunmetal composition containing tin 10, zinc 2, lead 0.5 per cent, and the remainder copper. During melting there was a slight loss of zinc and phosphorus, and a compensating surplus was allowed in the original charges. Phosphorus was added in amounts ranging from 0.02 to 0.15 per cent which left in the alloys, as cast, phosphorus contents from 0.002 to 0.131 per cent.

Analyses were made of drillings from two test-bars from each heat. The results of the analyses are shown in the accompanying table. Total impurities other than phosphorus were estimated in two cases, and as all the alloys were made from the same materials, it may be assumed that these impurities are present in all heats to approximately the same extent.

When the analyses of the series were completed, it was noticed that, possibly due to a fortuitous arrangement of the slight errors inseparable from weighing and melting large charges such as these under commercial conditions, there had resulted a regular increase in the zinc content and a decrease in the tin content throughout the series. Therefore, to dispel any suspicion that the observed effects which are being ascribed to the phosphorus content might be due to this regular change in the basis composition of the alloy another heat (No. 0) was prepared.

In this charge the composition was deliberately adjusted to bring the zinc content about 0.25 per cent high, and the tin content about 0.25 per cent low. The test results are seen to be practically identical with with those obtained from heat No. 1, and it is thought, therefore, that the whole series may be taken as being, for practical purposes, 88: 10:2, in the composition of which the only relevant variable is the phosphorus content.

Some explanation is necessary of the method of assessing the results of these tests and of the reasons for casting so many test-bars at different temperatures.

Casting Temperature Important

It is well known, both from the frequent comments by research workers and from the many practical dissertions on bronze foundry practice, that the casting temperature is an important factor governing the properties of bronze. It cannot be emphasized too strongly in fact, how critical this factor really is. It is the author's opinion that a large proportion of the published data on bronzes, especially those dealing with the effect of impurities, is of less value than might be due to lack of proper control of this factor.

It is only necessary to glance through the figures and the curves given in this article, and many other similar series of tests which have been published previously, to realize that the effect of casting temperature on the mechanical properties of bronze may be far more extensive than that of the most potent impurity commonly encountered. It is

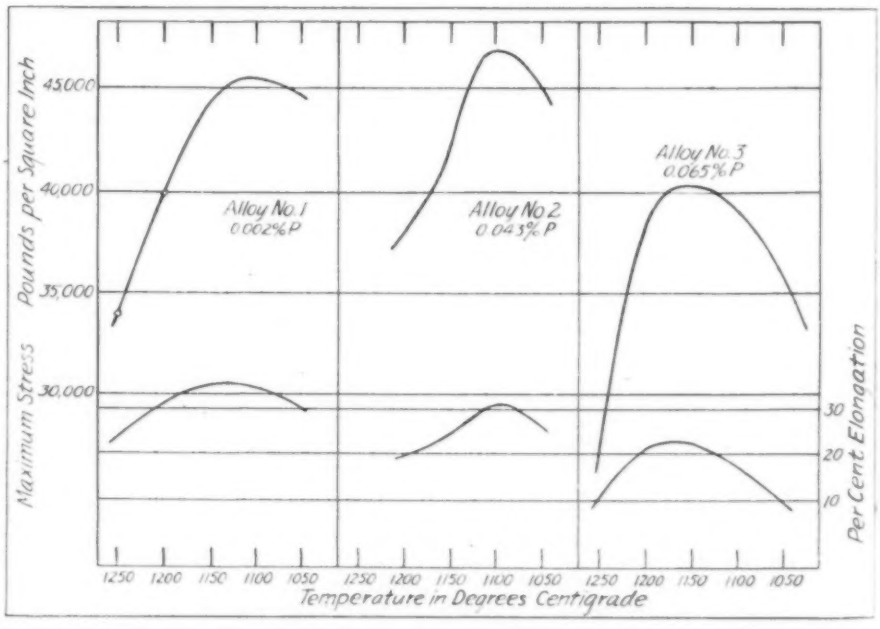


Fig. 4—Casting Temperature Effect on Strength and Elongation with 0.002 Per Cent Phosphorus. Fig. 5—Effect of Casting Temperature on Maximum Stress and Elongation with 0.043 Per Cent Phosphorus. Fig. 6—Effect of Pouring Temperature on Strength and Elongation with 0.065 Per Cent Phosphorus

extraordinarily difficult, nevertheless, to study bronzes on scientific principles by standardizing this variable and to avoid being misled continually by its effects.

The casting temperature is only the obvious controlling medium which brings about such extensive variations in the strength of bronze. The underlying causes are connected with the rate of crystallization and the temperature gradient in the mass which is freezing through a long temperature range. In addition to the casting temperature, there are other factors which influence the progress of crystallization.

There are the speed of pouring the metal into the mold and the volume, and volume to surface area ratio of the casting. The thermal conditions of the mold material also are important. The influence of casting the metal in chill or in sand molds, and if in sand molds the moisture content of sand, the density of ramming and even the type of sand all govern the freezing gradient.

Affect Freezing Range

If all these influences could be standardized accurately at the optimum values for a particular composition of bronze, the same conditions still would not be necessarily the best for any other composition. Many impurities, even in small amounts—and phosphorus is a case in point—markedly affect the freezing range and the fluidity of bronze, and, therefore, affect its capacity for freezing with its optimum strength values under particular casting conditions.

Molding conditions and the quality, moisture content, and method of preparation of the sand all have been standardized on what is thought to be sound practical lines, and the conclusions arrived at from the data in this paper obtained under these conditions could be safely applied to all green-sand castings. Chill-castings are excluded specifically from consideration in this paper.

It remains only to nullify the effect of casting temperature. That has been done by casting from each melt a range of test-bars at casting temperatures chosen approximately to cover the range of temperature within which even reasonably sound castings could be obtained. Properly reliable castings in practice could be obtained only within a much narrower range of casting temperature than has been employed in the tests.

Mechanical test results of the bars cast above and below what was expected to be the optimum casting temperature have been plotted in Figs. 4 to 8. In each figure a smooth curve has been drawn through all the points, and the peak of the curve in each case has been taken to represent the true strength of the alloy under consideration. The peak values obtained from the curves in Figs. 4 to 8 are plotted in Fig. 9.

The effect of phosphorus is seen to be most marked between 0.04 and 0.07 per cent. From a trace up to 0.04 per cent phosphorus, there is only a slight increase in the tensile strength and a slight decrease in the elongation. Above 0.04 per cent the tensile strength and elongation both drop sharply, but from 0.07 to 0.13 per cent phosphorus there is little further alteration in either value.

Microstructures of the alloys showed no unusual features. Throughout the series there prevailed the structure typical of cast gunmetal showing dendritic cored alpha solid solution with small inclusions of delta solution. There was no phosphide to be seen in alloys Nos. 1 and 2. In alloy No. 3, containing 0.065 per cent phosphorus, at high magnification small amounts of phosphide in some of the delta areas could be picked out, and in alloy No. 4 the phosphide lakes became more plentiful.

It appears that the solid solubility of phosphorus in sand-cast 88:10:2 gunmetal is of the order of 0.05 per cent, and the drop in mechanical strength at about this phosphorus content may be connected with the appearance of insoluble copper phosphide. It has been previously suggested by Rowe, *Proceedings* of the Institute of British Foundrymen, 1924, that the limiting solid solubility of phosphorus was about 0.03 per cent, and the figure suggested by the present research is of that order.

Determine Densities

For the determination of brinell hardness, flats were ground along the screwed ends of the broken test-bars, and the surfaces were polished down on emery-paper to No. 0 grade. The impressions were made with a standard machine, using a 10-millimeter ball, and a load of 500 kilograms. The load was applied for at least 15 seconds. Four impressions were made on each sample, and the average results are plotted in Fig. 2.

Densities of the specimens were determined by weighing in air and water, and were calculated relative to the density of water at 4 degrees Cent. Corrections were applied for the buoyancy of air, but no corrections were made for the temperature of the specimens. The values all refer, therefore, to the density at room temperature, which was about 16 degrees Cent. The figures are plotted in Fig. 3.

In closing it may be said that the effect of phosphorus on the tensile strength, elongation, brinell hardness, density, and microstructure of sand-cast admiralty gunmetal has been determined from 0.002 to 0.131 per cent phosphorus.

There is little change in the strength values with up to 0.04 per cent phosphorus. There is a sharp reduction between 0.04 and 0.07 per cent phosphorus, and there is little further change with from 0.07 to 0.13 per cent phosphorus.

There is a slight increase in brinell hardness as the phosphorus content is increased to 0.04 per cent, and a reduction in brinell hardness with further increase of phosphorus up to 0.13 per cent.

There is practically no change in the density with up to 0.06 per cent phosphorus, and a slight reduction as the phosphorus content is increased to 0.13 per cent.

The appearance of insoluble copper phosphide in sand-cast admiralty gunmetal is found to commence with about 0.05 per cent phosphorus.

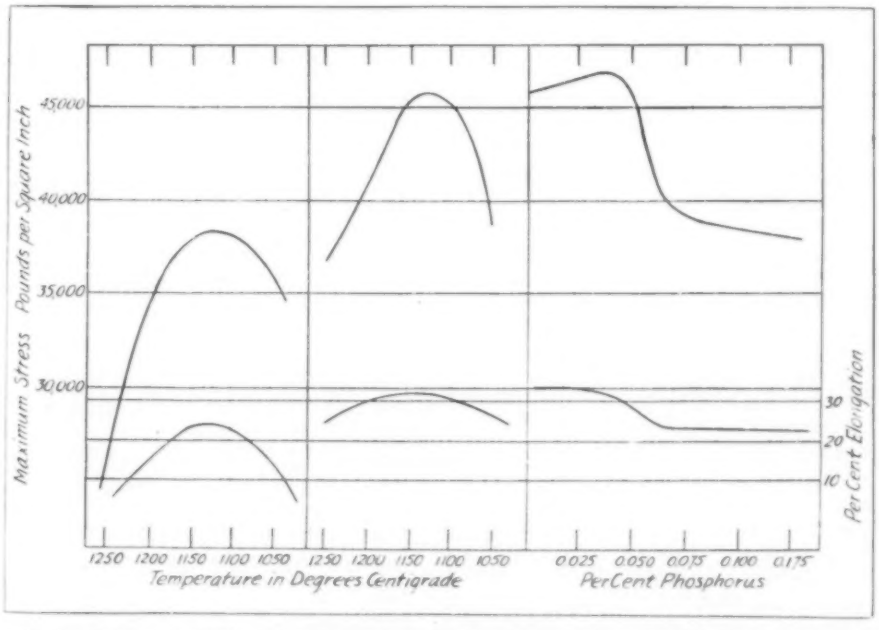


Fig. 7—Effect of Casting Temperature on Maximum Stress and Elongation with 0.131 Per Cent Phosphorus. Fig. 8—Casting Temperature Effect on Maximum Stress and Elongation with 0.002 Per Cent Phosphorus, Alloy No. 0. Fig. 9—Peak Values of Maximum Stress and Elongation with Varying Phosphorus Contents in the Alloys

Prevent Losses With Proper Gates and Risers

By Pat Dwyer

IN CONSIDERING some of the terms employed in the foundry a thoughtful person is forced to one of two conclusions. Either words have changed in meaning since the original name was bestowed, or, the name was coined on the spur of the moment without proper examination or reflection. For example consider the term *pouring cup*. If there is one part more than another essential to a cup it is a bottom. Without a bottom it is no longer a cup and certainly cannot fulfill any function for which a cup is intended. A cup in the ordinarily accepted sense is a small vessel used in conveying liquid (usually a beverage) from one point to another, as from a larger vessel to the lips of the drinker.

Meaning Is Explained

With the single exception that the pouring cup usually is circular in cross section, it resembles the original cup in no particular. It simply is a funnel to catch the comparatively wide stream of metal falling from the lip of the ladle and to direct it into an upright sprue. By a slight stretch of the imagination the device may be accepted as a cup where the main purpose of its employment is to increase the static pressure of the metal in the mold. In this instance, pouring is continued until the cup is filled to the top. The claim may be advanced that the device is a cup because it holds a supply of molten metal and that a small part of that metal is absorbed later by the sprue. However, that claim is weakened somewhat by the fact that a small body of metal deliberately set up to feed a sprue, or other opening above a casting is known as a feeding head, or simply as a head.

The term pouring cup is entrenched so firmly, that probably any attempt to substitute another name would receive neither support nor attention. The foregoing comments are offered by way of justification in continued use of a term which is not strictly accurate. Perhaps this reference may be the means of directing other foundrymen's attention to the need of more accurately descriptive terms and eventually a reform in this direction will be brought about.

In the meantime a pouring cup is a pouring cup and is made and set up according to one of three accepted methods shown in Fig. 23. In the first, a bushing, an iron or steel ring is placed on the board or plate *A*. Sand is shoveled or dropped from a bin to fill the space between the cone and the ring. The sand is rammed by a hand rammer, or the plate is mounted on a jolt machine, depending on the number of pouring cups required. The sand is scraped off flush with the top of the ring and then the ring is lifted off and inverted to appear as at *B*. It is then ready to be placed over the sprue on any given cope. The reader will note that it is a funnel, pure and simple and as such confers little credit on the imagination of the first man who referred to it as a cup.

Adopt Other Methods

The method of forming a pouring cup shown at *C* is practiced to some extent, but is not recommended except where the cup is made up before the cope is placed on the drag. The gate stick is placed in the sprue and a ring is placed around it as in the first instance.

Leave the Lid Off

A FUNNEL would be a more appropriate name for the device usually referred to as a pouring cup, but a name that has endured for such an extended period, probably will be continued indefinitely, or at least until foundrymen take concerted action on the subject of foundry nomenclature. A plea for a beginning in this line is continued in a discussion on the open versus the closed riser. Although the adherents of the closed riser are loyal and consistent in their belief, it is claimed that their belief is based on false premises, faulty observation and lack of that progressive spirit which prompts a man to carry out his own experiments and draw his own independent conclusions. The majority of castings require no risers. Where risers are a necessity, covers are not required over the openings.

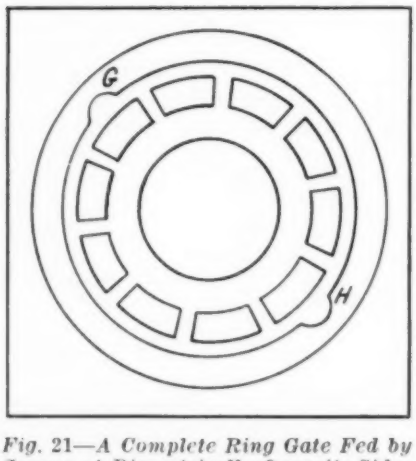


Fig. 21—A Complete Ring Gate Fed by Sprues at Diametrically Opposite Sides

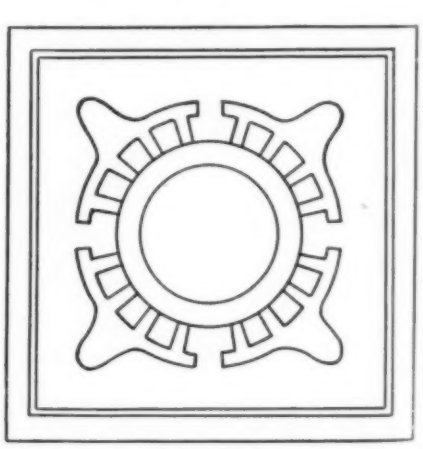


Fig. 22—Broken Ring Gate To Be Poured with Separate Ladles at the Four Corners of the Flask

Sand is packed around the gate stick and then the trowel or double ender is employed to clear away a funnel around the gate stick.

When the funnel has been roughed out, the gate stick is removed and the sand is slicked down as far as the junction between the sand in the ring and the sand in the cope. The principal objection to this method is that sand never can be slicked down with the tools as smooth and firm as it leaves the cone in the first method. The result is that it is disturbed easily by the falling stream of metal and a certain amount is washed into the mold.

Where a pouring cup of this kind is made up with the cope in place on the drag, a grave risk is incurred of having loose particles of sand roll down the sprue when the gate stick is removed. A great deal of care is required to smooth the sand properly, particularly at the acute angle where the sand touches the gate stick. The temptation is

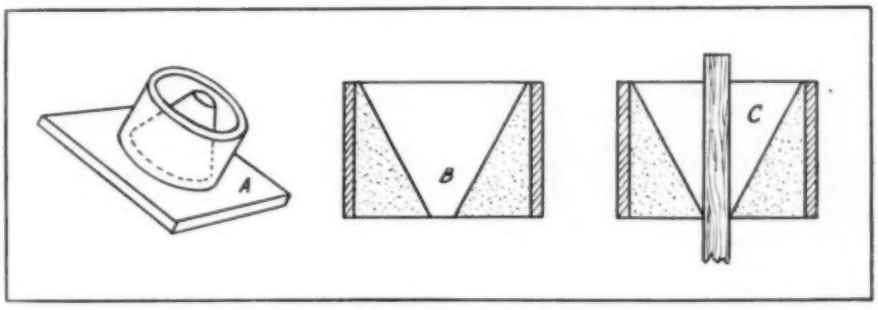


Fig. 23—Green Sand Pouring Cups May Be Made According to the Method Shown at the Right or at the Left

strong to apply the swab at this point. The remedy is quick but deceptive. The water will hold loose sand in place and deceive the inexperienced eye with its apparent security. The first dash of hot metal will wash away any sand held temporarily in that manner.

The third method, shown in Fig. 24 is employed universally in steel foundries and to some extent in foundries where other metals are melted. In the first and second methods outlined, green sand is the medium employed. In the third method the body of sand forming the funnel, is dried and therefore no bushing or reinforcing ring is required. The pouring cup in effect becomes a species of core, insofar as the term core is applied to all blocks of sand that pass through a drying oven.

In some instances where the cups are small or where only a small number are required, they are made from the regular core sand mixture, or from one of the mixtures, in the event that cores are made in great variety. Where the cups are made in great numbers, and of course this applies particularly to

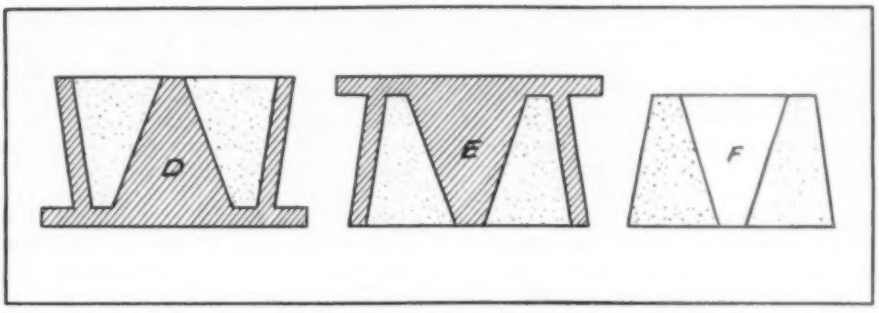


Fig. 24—Cast Iron Corebox for Cups To Be Used on a Jolt Machine

steel foundries where the metal is poured through bottom pour ladles, the cup cores are made from a mixture of old molding sand bonded with whatever species of core binder is in favor in the shop at the time.

Every core binder at present in use will function satisfactorily when employed with discretion and knowledge. However, foundrymen for various reasons develop likes and dislikes and as a result excellent binders are condemned in one foundry and extolled in another. A little experimentation with various sand combinations and varieties of binders usually will result in the development of a sand mixture particularly adapted to local conditions.

Pouring cup cores are made in a device somewhat similar to that shown in Fig. 24. This may be wood or metal and may be used on the bench for small numbers, or on a jolt machine where large numbers of cup cores are wanted. On a small rollover hand or power jolt machine an operator can make 700 of these cores per day. This refers to the ordinary size pouring cup 6 inches in diameter.

At *D* Fig. 24 the corebox is shown rammed full of sand and struck off. At *E* it is shown rolled over and at *F* the finished cup core is shown after the corebox has been removed. The cores are loaded on plates, placed in the core oven and dried in the usual manner. Where the service is not too severe and where the cup cores are in a position to be removed intact from the molds, they may be used on more than one occasion. Usually, however, this is doubtful economy, particularly where the work is entrusted to untrained men. Where either the sides of the funnel, or the edges of the lower orifice show signs of extensive disintegration after the first trial, the entire core should be discarded.

The device shown in Fig. 25 has been in use for many years in a foundry in the Middle West for making small green sand pouring cups. It is one of these happy shop kinks that combine the essence of simplicity and perfection. It is made up of a small cast iron platform, with projections on the top to locate the ring or bushing, a plunger to form the tapered opening and a lever on the lower side swinging horizontally from a bolt at one end.

In practice the operator places the small end of the plunger in the opening in the center of the plate

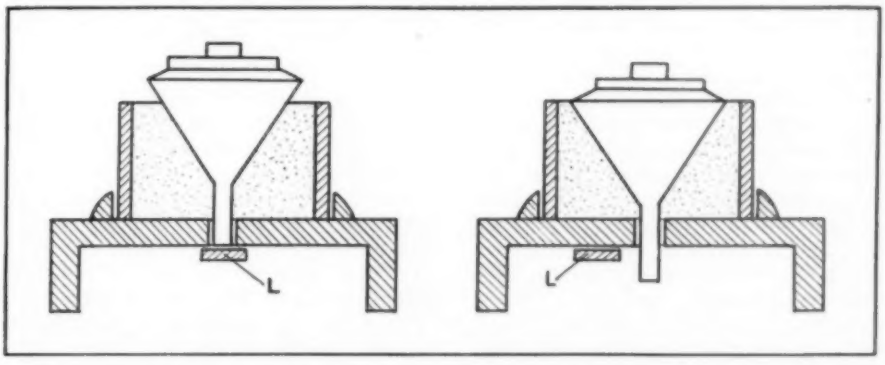


Fig. 25—When the Lever L Is Moved To One Side the Cone May Be Driven Down To Compress the Sand in the Cup as Shown at the Right

with the point resting on the lever underneath. He sets the ring in place and then throws in a small shovelfull of sand. With one hand he swings the lever to one side and with the other he hits the top of the plunger with a lead hammer. The impact drives the plunger down and the tapered shape compresses the sand.

As previously stated, the primary purpose of using pouring cups on some occasions is to increase the height of the head and thus insure sound castings under comparatively shallow copes. This feature will be considered more in detail later in a discussion of gating steel and certain types of nonferrous castings where the height of the head exerts a tremendous influence on the density and homogenity of the resulting casting.

Gates in a Ring

A ring gate is the term applied to an arrangement where a number of small gates conduct the metal from a circular runner to a mold in the center as shown in Fig. 21. This type of gate usually is located at the joint line between the cope and drag and is employed extensively on light, thin castings where a maximum amount of metal must be introduced in a minimum period of time to offset any danger of misruns or cold shuts.

Each of the branch gates is comparatively shallow, particularly at the inner end where it must be thinner than the casting. If the metal remaining in the gate is thicker than the casting at this point, it will not break off clean, but will break a piece out of the wall of the casting. This point was touched upon in Part I of this series where attention also was directed to the evil effects of filleting the edges of gates and risers. The metal in a gate or riser of that kind either will break a piece out of the face of the casting, or, it will break off in a manner to leave a short and unsightly stump which increases the cost in the cleaning room.

The number of sprues required to supply a ring of gates with metal depends on several factors including the total amount of metal, the thickness of the casting wall, the total distance the metal has to run and, perhaps to some extent, the temperature of the iron. Usually only metal of extremely high temperature, approximately 2600 degrees Fahr., is employed to pour castings gated in the manner shown in Fig. 21, but in some foundries the molten metal never attains this high temperature and as a result it is necessary to use larger sprues, or a greater number for the distribution of any weight of metal.

In some instances a single sprue is sufficient. In others, two are employed diametrically opposite each other as shown at *G* and *H* and in extreme instances the metal may be poured down four sprues spaced equidistantly, usually in the four corners of a square flask. In the latter instance it is not customary to include a complete ring for the runner. Each sprue feeds a detached segment of the runner and the runner in turn discharges the metal through one quarter of the total number of gates as illustrated in Fig. 22.

Obviously where metal is poured simultaneously into a mold from four ladles, the mold will fill more rapidly than where only one or two ladles are employed. In thin castings speed of pouring is the most important factor to be considered. Molten iron may and does remain liquid for a comparatively long period in a thick, heavy casting. Therefore a wide latitude is permissible in the speed with which the metal is introduced. Limiting factors, the character of the sand in the cope, a chill face, or low temperature may dictate the advisability of pouring a heavy casting as rapidly as possible, but usually a variation of speed is not reflected in the appearance of the casting.

On many light castings the entire success of the molding process depends on the speed with which the molten metal is introduced. Unless it is driven in hard and fast through generous gate openings, it will not fill the mold.

Molten metal is a liquid only so long as it remains within a definite range of temperatures. The melting point of gray iron is between 2100 and 2400 degrees Fahr., depending on the carbon and silicon content. The boiling point of pure iron is given as 2450 degrees Cent., or 4442 degrees Fahr. This point never is reached in commercial foundry practice. For all practical purpose molten iron may be regarded as molten only so long as it remains between 2100 degrees and 2800 degrees Fahr., with the average pouring temperature of 2400 degrees where large heavy castings are concerned, and 2600 to 2700 degrees in light thin castings.

Risers Are Not Needed

From the foregoing it is evident that the available pouring range is limited and naturally the drop below this range is most rapid where a small quantity of metal is spread over a large area. High velocity is required to carry it to its destination before solidification sets in. In this respect the art of pouring light castings may be compared to the trick of skipping a flat stone over a body of water. Under sufficient impetus the stone will travel a considerable distance before the difference in specific gravity of stone and water, causes it to sink to the bottom.

In this connection it is interesting to note that no risers are employed on the molds where rapid pouring is practiced most widely, that it is the stove plate foundries. This would seem to indicate a flaw some place in the theory held by one school of foundrymen, that unless a definite exit is provided for the air in the mold, the iron will not fill the mold readily.

This theory might hold with a solid mold of some material impervious to air, but it lacks plausibility when applied to a material as open and porous as the sand in the walls of a green or dry sand mold.

Hold Up the Cope

Perhaps this is as opportune occasion as any other to direct attention to another peculiar belief which at one time obtained universal credence and which still has its champions when the questions of open versus closed risers, comes up for discussion.

Actual observation should convince any person that air can escape through the sand from any mold, much more rapidly than iron can fill the same mold. At no time is the air under compression. The popular theory that the air is compressed to a point where it helps to support the sand face of the cope is not borne out in any well made mold. Without any question, internal commotion in a mold whether caused by gas or steam, will cause the air to blow with force through the riser. Clapping a cover on the riser will hide the evidence of what is going on inside the mold, but the extra volume of gas and steam will escape through the sand walls. In extreme instances the pressure is developed to a point that will raise the cover on the riser, but that simply is evidence of a defective mold. On molds that are prepared properly in all respects, the metal flows into the mold cavity and up into the riser without creating any rush of air through the riser.

Tradition and custom play a more important part than common sense in many foundries. In the great majority of instances, no riser is required on a casting. In instances where risers are required as showups, flowoffs or feeders, no necessity exists for covering them. An ordinary mold that can be poured readily when equipped with a riser, may be poured just as readily without the riser. A mold that will kick and boil under an open riser, will kick and boil just as violently under a riser that is covered.

Any molder engaged in a search for the truth, instead of opinion to

back up early prejudice, easily can convince himself of the accuracy of the foregoing statement. All he has to do is to omit the riser from a few molds, formerly decorated with this useless appendage. Refrain from covering the risers on jobs where risers are needed and watch the iron rising in them gently, evidence of well made molds. A light cover is advisable where danger exists of sand or other foreign material falling down the risers at any time before the iron is poured into the mold, but in the majority of instances even this cover is not necessary.

This feature was touched upon in a previous issue of this series, but the fact that obsolete practice still prevails to some extent, particularly in jobbing gray iron foundries, seems to warrant the repetition. Also the reader may have missed the previous issue.

This is the fifth of a series of articles dealing with the various types of gates and risers used in the foundry industry. The sixth will appear in an early issue.—THE EDITORS.

Needs Special Foundry Training

By P. R. Hall

WHILE in college an engineering student gets a general training on many subjects. However if he is to be developed into an engineer for a particular company he must have some special training after graduation. This is true in any field where the engineer is employed and is just as true of the engineer entering the foundry industry.

Many industrial organizations have developed courses which are taken by young engineers. The following is an outline of the course given to engineering graduates by a railroad company.

Machine shop	1 year
Erecting shop	1 year
Boiler shop	2 months
Study flues, patches, federal laws, etc.	
Freight car shops	2 months
Study trucks, body, air brakes and inspection.	
Round house	4 months
Study cleaning fire, fueling, watering, repairing and the paper work of despatching and reports.	
Inspecting incoming locomotives	1 month
Inspecting outgoing locomotives	1 month

A similar course can be given to engineering graduates entering the foundry industry. This would vary in content for different foundries to meet their local conditions.

	Months
Core room	2
Molding floor	6
Sand testing	1
Cranes	1
Melting department	2
Cleaning department	2
Inspection	1
Pattern making	2
Pattern storage	1
Design department	6

The training should be under the direction and supervision of a man in the organization who will see that the program is carried out. He must check the engineering graduate taking the course to see that he is making a study of the department in which he is working.

When the engineer is transferred to the next department he should write a report on the work he has done in the department he is leaving. This report should give a list of the work covered in the department, suggestions for improvements in the course to be given to future engineers and suggestions for improvements in the routine working of the department.

In each department he should acquire a certain amount of skill in doing the work, and should study the material and apparatus used. In the core room he should learn to make cores, and make a study of core sand mixtures, core oils and compounds, core boxes, core making machines, core oven design, core oven temperatures and heating, and sand mixing machines. A catalogue file will furnish much information on these subjects, and text books will help him to acquire the necessary information.

On the molding floor he should learn to make snap and floor molds; should make a study of molding machines and the proper method of arranging a pattern on them, and air rammers, flasks and rigging.

In the sand testing laboratory he should have instruction on testing molding and core sand, and the proper grades of sand to use for different classes of castings. He should learn the best type to use for large or small castings and for brass, bronze, cast iron, malleable iron, steel, and aluminum. The engineer should learn to run a crane, also any other lifting equipment in the shop. He should study the different kinds of cranes and the rigging used on them to lift the molds and ladles.

The work in the melting department should include instruction in operating the particular types of units employed in the particular foundry, as well as instruction on other melting furnaces. A study should be made of the design and best methods of charging and operating these furnaces. The course should include a study of metallurgical reactions which take place in these furnaces.

In the cleaning department the student should learn the proper way to charge and run a tumbling barrel sandblast room and air tools. He should make a study of the different kinds and makes of cleaning equipment. His time in the inspection department should give him a knowledge of the castings manufactured by the firm, and show him the difference between a good casting and a poorly made casting.

As many foundry problems have to be decided before the pattern goes to the foundry, the foundry engineer should have a knowledge of pattern making. Although only two months have been allowed on the outline, in many foundry organizations this should be lengthened to a year or more. The two months would be the time necessary when the firm only makes a small percentage of the patterns it uses.

Two things are necessary in a pattern storage, the patterns should be located easily and they should be cared for in such a way that they will be in condition for use when removed from the storage racks. During the time he is working in the pattern storage he should study the different systems used for locating patterns also the proper conditions under which a pattern should be stored so that it is kept in good condition.

Two kind of problems in design will be necessary for the foundry engineer to master, those of production and those of equipment. In production design he must study the changes which take place when a casting cools and design the castings to take advantage of these changes.

A slight change in design will often be the difference between a solid strong casting and a defective one. The foundry engineer will be the one to decide on these changes or convince the customer that they should be made, therefore, he should make a study of the principles used in designing castings. The foundry engineer must study design from the standpoint of furnishing the proper flask and other equipment used in the foundry to make castings.

Casts Large Bronze DOOR for Parthenon in NASHVILLE

By B. K. Price

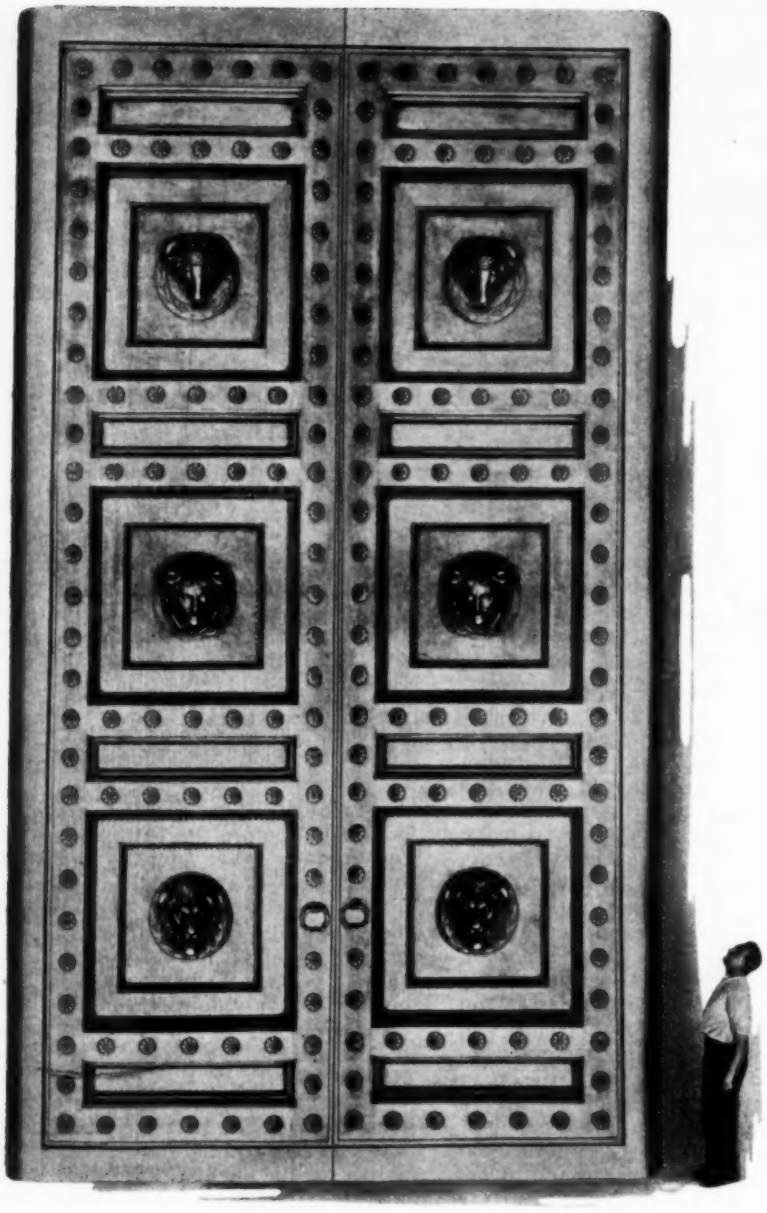


Fig. 1—Front View of the Large Bronze Door Showing the Design

ONE of the largest bronze doors ever cast, recently was installed in the new Parthenon located in Centennial park, Nashville, Tenn. This door is 23 feet 6¾ inches in height and 12 feet 10½ inches in width. In addition to its great size, the door is notable in that it duplicates in measurement and, insofar as archeologists can ascertain, the exterior design of the famous door that swung in the entrance of the Parthenon of the Acropolis, Greece, many centuries ago.

The principal difference appears to lie in the construction. According to the conclusion formed by the eminent archeologist, William Bell Dinsmoor, New York, the original door was made of wood covered by bronze plates, whereas the present door is made of bronze castings, 5/16 inches thick, welded, and supported on the inside by structural steel. The operating and locking mechanism of the newly constructed door is along modern lines.

Installation of this door marks the completion of the Nashville Parthenon, which originally was conceived in the late nineties, when the people of Tennessee became imbued with a desire to erect a structure of surpassing beauty for an exposition to be held in Nashville in commemoration of the 100th anniversary of the state's entry into the Union.

The first building was erected of wood and plaster. It was built hastily, but not so hastily as to do violence to the design of the original structure, which long since, ravaged by wars and time, has laid in majectic ruin on the hill overlooking Athens.

The building proved of widespread interest, and several years later, when the exposition grounds had been overrun with weeds and other buildings had been dismantled and taken away, this structure, alone, remained. The people of Tennessee wished it to remain.

In 1920, following many repairs, it was adjudged unsafe and the city park commission under whose jurisdiction the exposition had come, was provided with sufficient funds for the erection of a new, more lasting and even more authentic structure. Hart, Freeland & Roberts, Nashville, were retained as architects. They surrounded themselves with prominent archeologists and also with such leading sculptors as George J. Zolnay, who was appointed to do the metopes and Belle Kinney and Leopold Scholtz, to do the pediments.

Research studies of the Grecian Parthenon, which had engaged the attention of outstanding archeologists for more than 250 years, became even more intensive. The ruin itself, was the chief source of information. Of vast assistance were the fragments, which had been excavated on the Acropolis and preserved by archeological societies throughout the world, and also drawings of the sculptures on the Parthenon by Jacques Carrey, an attache at the French embassy in Constantinople, in 1640.

With steel and concrete the basic materials and with the concrete especially treated to give the color of

Pentalic marble, the restoration of the Parthenon at Nashville finally got under way. In 1925 the exterior was finished, but it was not until recently that the interior, with its more complex problems, was completed. Some phases of the work to be conducted along conjectural lines, for there are still gaps in the true picture of the original which if it ever is supplied, may take years of research.

Incidentally, there is one deliberate omission, namely, the large statue of the Goddess Athena. As described this statue was 40 feet high, of gold and ivory, and was dedicated at the Panathenaic festival in 483 B. C. As every last fragment of the statue has disappeared, there remains only a few small copies on coins, or as small sculptures. Presumably, with so little to guide them, the sculptors on the Nashville Parthenon did not care to risk profanation.

In addition, there are such intentional deviations, as the lecture room in the basement, approached by discreetly placed stairways, and, of course, the modern heating and lighting systems. Incidentally, the building is heated by an oil burner housed approximately 1000 feet away. However, in all but a few details, the work carries the stamp of authenticity, a truly beautiful copy, so architects declare, of what never can be duplicated.

Ornaments Are Cast

With specific reference to the door, Mr. Dinsmoor, who supplied the details of design, was forced to consult ancient writings on the question of ornamentation, finally deciding upon the incorporation of the two ram heads, the Gorgon heads and the two lion heads, shown in the accompanying illustration of the door. These special decorations were cast separately by the *lost wax* method, the only pieces thus cast.

All of the casting and assembling work was done by the General Bronze Corp., Long Island city. The door was built up chiefly of eight cast segments, four to each wing. In addition cast strips formed the meeting stiles, and bronze sheet coverings were fitted around the 5-inch steel shafts upon which the wings are swung.

As previously indicated, these parts were welded together, and upon assembly held into place by 12-inch H-columns and channels. These structural members were screwed to lugs on the back of the main castings, which constitute the front and back of the door. Screws were inserted from the outside only through the meeting stiles and where this was done the heads were filed off so as to leave the surface smooth.

Size of Segments Varies

The eight principal cast segments fell into two groups according to size. Each of the four larger weighed about 2200 pounds, and were approximately 6 by 16 feet. These segments comprised the lower sections, two to each wing, one front and one back. Each of the smaller four weighed 1500 pounds and were approximately 6 by 8 feet. All of these castings were 5/16-inch in thickness. The door was provided with a wicket so as to allow passage, without necessarily opening an entire wing.

The bronze was a mixture, comprising 87 per cent copper, 8 per cent zinc, 3 per cent tin and 2 per cent lead. Except for the special ornamental pieces, all work was cast in skin dried molds. In view of the success the company had in skin-dried molds for large castings, it did not feel the necessity of installing ovens for the particular purpose. In the instance of the Nashville job the company continued to enjoy success with the skin dried molds, not one of the castings being lost.

The sand consisted of a mixture of one-half of used Albany sand, one-quarter of new Albany sand and one-quarter of new French sand, the latter also being used for the facing. After being thoroughly ground and mixed, it was applied to the pattern and air-rammed to the required hardness. To obtain the best possible work, it was necessary to reface the sand by spraying the mold with water and then shaking on some dry French sand before placing the pattern back into the mold. Patterns were made of wood for the plain sections, and of metal, mostly tin with some antimony, for the ornamental pieces, the metal patterns being applied to the wooden background.

In view of the unusually large area of some of the various castings, it was necessary to use an especially built iron flask that, with the sand, weighed more than 40 tons. This weight exceeded the capacity of the company's largest crane, making it necessary to have two cranes in turning over the flask. The largest flask was 8 feet wide, 20 feet long and about 16 inches deep. This was used for molding the four largest sections. As it later developed a somewhat shorter flask could have been used, for following its construction there was a slight variance in the procedure. When it came to the casting of the four smaller segments, this flask was reduced in size.

Melted with Difficulty

There was also difficulty in melting enough for one pour, it being necessary to pour as much as 3100 pounds at one time. As a result, the company used two crucibles to supplement its three electric furnaces of which the three electric furnaces had a capacity of 1500 pounds each, and the two crucibles 500 pounds each, making an aggregate capacity of 5500 pounds. However, as the electric furnaces were of the induction type it was necessary to retain a portion of the molten metal to serve as a secondary in melting the next heat.

In pouring the metal for the largest castings the company used four reservoirs, locating them centerly on the cope, with distributing sprues running at an angle to the side of the casting as well as through the center. The company also used a runner around the edge of the casting where it had deep flanges.

Quick handling was necessary in

(*Concluded on Page 76*)

Fig. 2—A Beautiful Copy of the Parthenon at Athens, Greece, Has Been Constructed at Nashville

Gray Iron

Possesses

Valuable Engineering Properties

UTILIZATION of metals at elevated temperatures makes knowledge of their properties and behavior under such conditions essential. In case of gray iron it is only within recent years that much attention has been given to accurate determination of its properties at elevated temperatures and to possible modifcation of its room temperature properties by thermal or heat treatments. Also, it may be pointed out that a leading engineering society has limited the use of gray iron in pressure containing parts to applications not exceeding 450 degrees Fahr. operating temperature, whereas it is probable that certain grades can be used safely and economically at 600 to 700 degrees Fahr. and in some cases possibly at 800 degrees Fahr.

When molten, gray iron consists of a liquid solution of iron and iron carbide, as indicated in Fig. 83, as the solution cools, the crystals which first separate form a solid solution known as austenite. The solubility of iron carbide in the austenite is limited and becomes lower with decrease in temperature. Nearly all commercial cast irons contain somewhat less than the eutectic percentage of iron carbide, corresponding to 4.3 per cent carbon in pure iron carbon alloys. The eutectic is indicated by point *E* on the diagram. The saturated austenite on crystallizing at lower and lower temperatures throws out the more liquid cementite-rich portion of the metal, leaving the solid lower carbon crystals of primary austenite. These crystals fern-like in appearance, often are found in the interior of shrinkage cavities. The fern-like crystals or dendrites when analyzed are found to be comparatively low in total carbon. The more liquid, richer in carbon, portion has been drawn away during the processes of contraction occurring during solidification of the dendrites at the solidification temperature.

As temperature is lowered the austenite crystals grow, becoming richer in carbon at their exteriors and still throwing off the liquid carbide-rich portions of the melt. When the line *X Y*, in temperature is reached the remaining liquid freezes suddenly as the austenite-cementite eutectic, ledeburite. Thus if chilled suddenly from somewhat above the line *X Y*, gray iron is found on consist of austenite dendrites, with the cementite-saturated austenite euctectic, ledeburite, between. This is shown in Fig. 87. The dark areas are austenite, the mottled white areas the eutectic ledeburite. Below the line *X Y*, the metal is completely solidified. Now, when considerable silicon is present, the cementite of the ledeburite is decomposed readily forming its ultimate components, iron and graphite, providing sufficient time is allowed. Therefore, immediately below *X Y* we have austenite, saturated with carbide for the temperature in

Limits Temperatures

WHILE many designers believe that gray iron is not suitable for pressure resisting castings at temperatures above 450 degrees Fahr., investigations carried out within the past few years have indicated that high quality gray iron can be used safely at temperatures from 600 to 700, and in some instances up to 800 degrees Fahr. Tests of gray iron at low temperatures such as the boiling point of liquid air, indicate that there is but slight change in its tensile strength and hardness. However, in designing apparatus for low temperature work, consideration must be given to thermal contraction just as in the case of expansions in elevated temperature conditions.

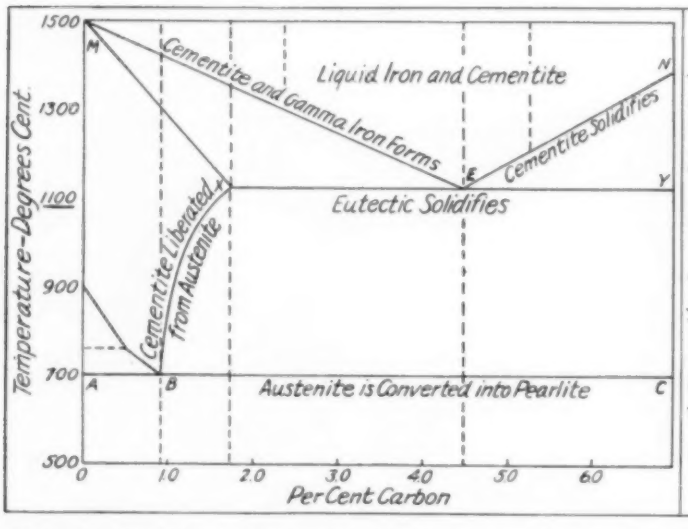


Fig. 83—Iron-Carbon Diagram after Sauveur.

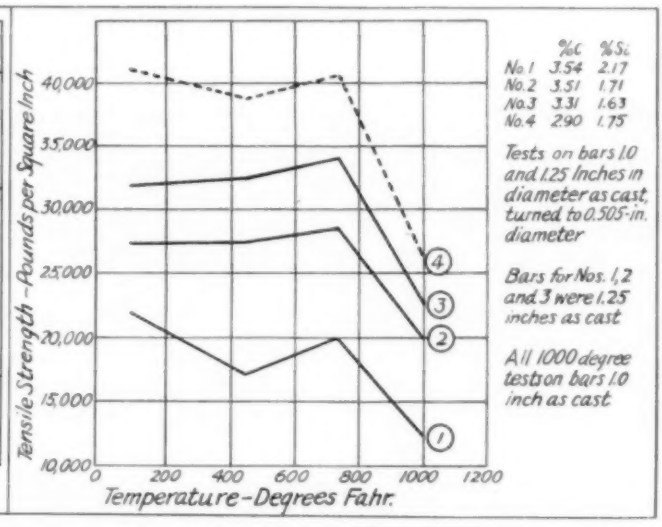


Fig. 84—Tensile Strength Tests on Various Irons at Elevated Temperatures According to Bolton

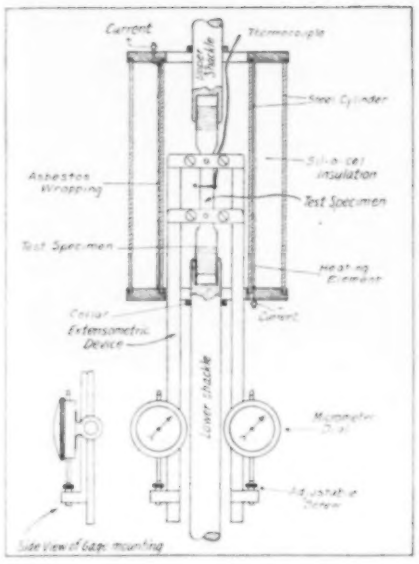


Fig. 85—Tensile Tests Conducted at Elevated Temperatures

reference and also the free graphite.

On cooling from the line *X Y* to the line *A B C* several other reactions occur. The austenite saturated at point *X*, has its carbide retention lowered as the temperature is lowered. The excess carbide is rejected as pro-eutectic cementite, the limiting solubility lying along the curve *BX*. Under ordinary foundry conditions of cooling and in presence of silicon this pro-eutectic cementite (iron carbide) also is broken down into iron and graphitic carbon. If time is sufficient the austenite itself losses further carbon as graphite. At the line *ABC* (usually about 1350 degrees Fahr. for commercial gray irons) the remaining austenite is converted into pearlite. Thus, if there is sufficient silicon and cooling rates are like those encountered in usual casting practice, below the line *ABC* we have pearlite, ferrite and graphite, the usual condition in commercial gray iron. If cooling and composition have been regulated carefully we may have all pearlite and graphite, pearlitic iron. If cooling has been to rapid there may be some free cementite, iron carbide, hence chill spots, white or mottled iron. However if cooling has been quite slow from liquidus to somewhat below the eutectoid arrest the time approaches that required for equilibrium. In that case we have all graphite and ferrite. (In all these examples we are omitting the effects of phosphorus and the formation of the phosphorus rich component steadite).

This is the state of stable equilibrium for iron carbon alloys, the condition of minimum thermodynamic potentiality, the condition approaching least *internal energy*.

On heating up, reactions are the reverse of those met on cooling down from the molten state. The main thing to remember is that all iron structures except the graphite-ferrite structure are metastable. Other structures tend to approach the stable structure, graphite-ferrite, up to the eutectoid temperature 1350 degrees Fahr. Above that point carbon is reabsorbed, forming austenite. The carbon concentration of the austenite increases with increase in temperature above 1350 degrees Fahr.

Effects of elevated temperatures on gray iron depend on occurrence of the reactions mentioned, the changes in plasticity of the components, and on the changes in susceptibility to corrosion. Summarizing it may be stated that below 1350 degrees Fahr. gray irons (pearlite-ferrite-graphite) are unstable, seeking to gain the stable condition graphite-ferrite. At lower temperatures, say under 900 degrees Fahr. the plasticity of the metal is low and the reactions quite slow, so slow as to be disregarded safely at temperatures up to 600 to 700 degrees Fahr. and possibly 800 degrees Fahr. for some irons.

Castings Have Strains

As is well known to foundrymen and machine shop men, most castings have internal stresses (strains). Even at room temperatures there often is sufficient plasticity so that long time aging removes such internal stresses. Marked increase in plasticity at higher temperatures, and below the possible point of graphitization, allows readjustment of these stresses in a fraction of the time needed at room temperatures. However, under external stress applied over long periods of time this same plasticity may allow creep, flow, distortion, and possible failure of the structure. The temperature-stress conditions which limit the safe applications of gray irons should be determined carefully. Much data along these lines have been published on the properties of steel, some on nonferrous metals, and little indeed on gray irons.

External corrosion of ordinary ferrous materials at elevated temperatures is commonly known as scaling.

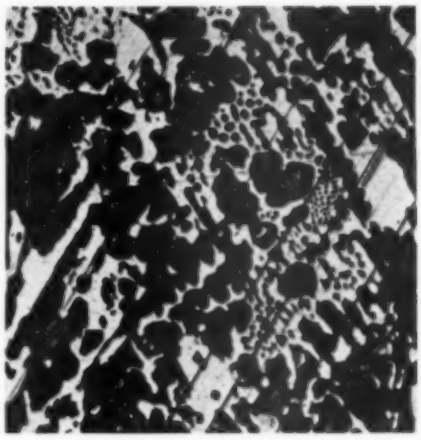


Fig. 87—Structure of White or Chilled Cast Iron

However, gray iron, particularly open-grained, weak grades, is subject to another and sometimes dangerous form of corrosion. This, at temperatures below the graphitization range, is internal corrosion, or oxidation, manifested in lower temperature growth phenomena.

To test the properties of gray iron at elevated temperatures it is necessary to employ some form of apparatus in which the sample can be held at the desired temperature during the test. The more common form of apparatus is the ordinary tubular furnace heated by a nickel-chromium alloy resistance wire. The setup for a tensile test is shown diagramatically in Fig. 85. In the tensile test the sample is held in the upper and lower shackles as shown in Fig. 85. The extensometer, constructed of metal of low expansion is fastened to the specimen by two small set screws.

Expansion is measured by two dial gages. A thermocouple leading to a compensated pyrometer indicator is fastened to the specimen itself. The furnace, in place as shown in the illustration is brought to temperature. It is controlled by a pyrometer setup

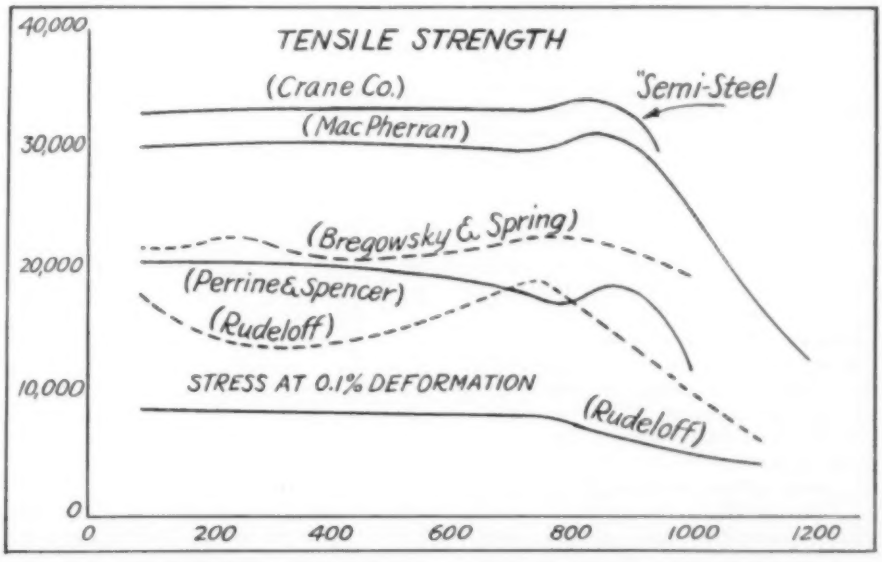


Fig. 86—Curves of Gray Irons at Elevated Temperatures

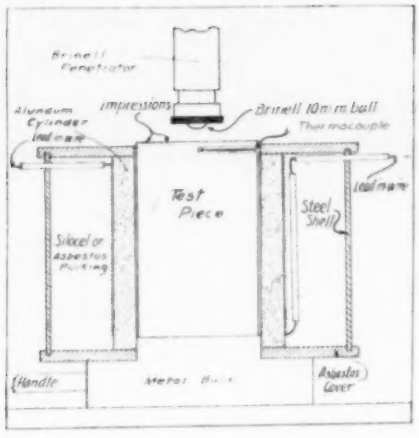


Fig. 88—Arrangement for High Temperature Brinell Test

with a thermocouple mounted in the furnace and the leads connected with an automatic control millivoltmeter or potentiometer. The setup is adjusted so that temperature is held constant at that point at which the *specimen* couple indicates as the correct temperature. In some cases the specimen couple is connected to the automatic controller. Due to lag this method is not as sensitive as the method outlined.

Among other types of extensometric equipment are the micrometer telescope and optical lever extensometers. In general the extensometer dial gage system gives more satisfactory results than the micrometer telescope or in some instances pair of telescopes. The optical lever extensometers are used for extremely delicate work. The Tuckerman-Martens type has been employed at the bureau of standards.

After bringing to heat, temperature is held for about 30 minutes before stress is applied and final extensometer zero adjustment made. This is to insure thorough soaking and equality of temperature throughout. Stress is applied exactly as in the regular tensile test and stress strain diagram constructed in a similar manner. All precautions to insure axial load etc. are the same as for the room temperature test.

Some results on ultimate strength are shown in Fig. 86 which is taken from the American Society for Testing Materials' symposium on effect of temperature on the properties of metals. Fig. 84 is taken from Bolton's paper "Research Problems of the Gray Iron Foundry," in *Transactions* of the American Foundrymen's association, 1928. It shows the effects of elevated temperature on tensile strengths of several irons of quite different analyses. More points should have been determined in the range 750 to 1000 degrees Fahr., as other tests indicate that strength is maintained to well above 800 degrees Fahr. The exact effects in that range were not determined in the tests.

Gray irons, irrespective of grades, from short time tests appear to have a slight change in tensile strength between room temperature and 800 degrees Fahr. In certain cases a slight increase appears between 600 and 800 degrees Fahr. Above 900 degress there is sharp lowering in tensile strength in all grades. Compared to most nonferrous metals, particularly copper and aluminum alloys, cast iron exhibits smaller variation in its properties with changes in temperature. Insofar as ultimate tensile strength is concerned there is less change than in some steels. Gray iron and malleable cast iron exhibit quite constant tensile strength up to or slightly above 800 degrees Fahr. on short time tests.

A previous installment, Part IX on fatigue and impact, showed that endurance limit is little if any lowered up to 800 degrees Fahr. and above that temperature the ratio of endurance temperature to ultimate strength increases. Brinell hardness is unchanged up to 800 degrees Fahr., according to all references found in the literature. Setup for conducting the hot brinell test is shown in Fig. 88. However stress-strain diagrams indicate lowered relative modulus of elasticity at elevated temperatures. Fig. 89 shows stress-strain curves for a high test iron as determined at room temperature (70 degrees), 450 degrees, and 750 degrees Fahr. A given stress produces a greater elongation, hence lowered modulus of elasticity.

In Fig. 90 a number of stress-strain diagrams constructed from tests conducted at 1000 degrees Fahr. are grouped. These tests, as shown were made on several types of iron and on several bars of different diameters as cast on one iron marked *A*. As noted in Fig. 90 these stress-strain diagrams are incomplete as the extensometer was removed before breaking of the specimen had occurred.

Two characteristics are notable: (1) The different irons have stress-strain diagrams which preserve the stress-strain relationships in the same order shown for these same type irons at room temperature tests, that is the stronger irons possessing greater (comparative) elastic moduli, also are stronger and possess higher (comparative) elastic moduli at 1000 degrees Fahr. (2) A given grade of iron has lower strength and lowered (comparative) elastic modulus as the test bar size is increased—relatively the same phenomenon found at room temperature. However, those interested in design must not forget that these are short time tests, not long timo tests.

It is of value to give some consideration to tests at temperatures lower than room temperature. Does gray iron become weaker and more brittle when exposed to extreme cold? The British Oxygen Co. Ltd. in 1927 published results of tests on gray iron at the temperature of the boiling point of liquid air, some 317 degrees below zero Fahr. The iron was of the following analysis: Silicon, 2.25 per cent; sulphur, 0.10 per cent; phosphorus, 1.2 per cent; manganese, 0.45 per cent, total carbon, 3.30 per cent, and combined carbon, 0.50 per cent. Tests showed that at room temperature the iron had a tensile strength of 29,836 pounds per square inch and a brinell hardness of 235. At the boiling point of liquid air, the tensile strength dropped slightly to 29,210 pounds per square inch but the brinell hardness remained the same. There was no difference apparent in the fractures of the two bars.

Later a systematic investigation of the subject was undertaken in Germany by Pardun and Vierhaus and

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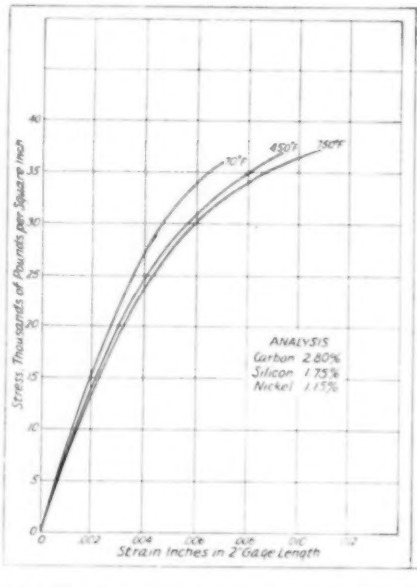


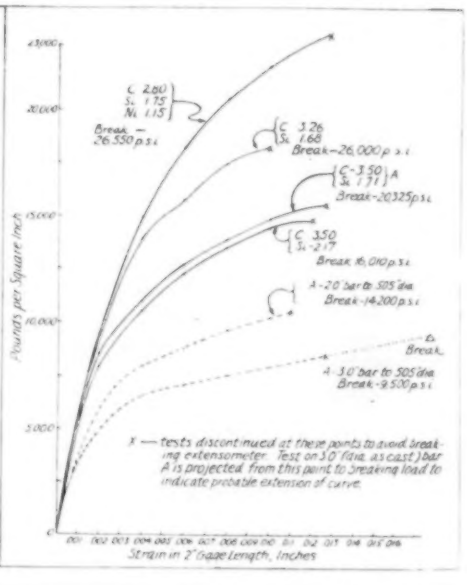


Fig. 89—Comparative Stress-strain Diagram of a Gray Iron at Elevated Temperatures. Fig. 90—Same for Various Irons with Tests Made on 1-inch Diameter Bars Turned to 0.505-inch except as Noted. Temperature 1000 Degrees Fahr.

While Representatives of Wisconsin Foundries Were Predominant, the Annual Foundry Conference Held at Madison Drew Many Foundrymen from Adjoining States

WISCONSIN GROUP Arranges Interesting Conference

KEEN interest coupled with active participation in discussions relating to shop problems featured the fifth annual foundry conference sponsored by the department of mining and metallurgy, University of Wisconsin and held at Madison, Wis. Over 100 foundrymen from Wisconsin, Illinois and Michigan attended the sessions held on Feb. 3, 4 and 5. At the opening session, George M. Enos, University of Cincinnati, Cincinnati, presented a short talk on the flow of metals in molds. Ralph S. MacPherran, Allis-Chalmers Mfg. Co., Milwaukee, then gave a brief picture of the gray iron foundry from his 36 years connection with it. He stated that the foundry industry is progressing steadily and not standing still as is claimed. He illustrated that fact by quoting some tensile strength values obtained from test pieces removed from a large casting made recently and a similar one cast years ago.

Strength Has Doubled

Test pieces taken from a 7-inch section of the recently made casting showed a strength of 30,000 pounds per square inch compared to 15,000 pounds per square inch for the one made years ago. The values on 2½ inch sections were 40,000 and 22,000 pounds per square inch respectively for the new and the old castings. Mr. MacPherran stated that pig iron today is more uniform and of equal quality to that produced 30 years ago. He also stated that more progress had been made in the gray iron foundry during the past 5 years than in the previous twenty years.

M. J. Evans, Whiting Corp., Harvey, Ill., in a talk on the foundry industry stated the future of the industry depends upon the degree to which fundamental facts are understood and applied. He pointed out that foundrymen apparently lack the determination to study details, and then standardize upon them. Mr. Evans also suggested a closer cooperation between the management and the employes as many valuable ideas could be obtained from the men who were in closer contact with operation.

Roundtable Discussion Held

Following the opening session a dinner was held in the Wisconsin Memorial union at which Associate Justice J. D. Wickhem, Wisconsin supreme court was the speaker. Wednesday morning's sessions opened with a lecture on pig iron by Prof. R. S. McCaffery, University of Wisconsin, and laboratory demonstrations on pyrometers and sand testing by Prof. J. F. Oesterle, and E. C. Cunningham. Those were followed by simultaneous sessions on steelmaking processes which were outlined by Prof. McCaffery, and a round table discussion of gray iron problems under the direction of C. J. Scullin, St. Louis, and D. J. Reese, Whiting Corp., Harvey, Ill.

During the discussion on gray iron one speaker mentioned he had noticed that iron at the spout of his cupola decreased in temperature after about 1½ hours of operation, and corrected itself after 10 or 20 minutes. Opinions indicated that the difficulty was caused by either too much or too little coke at that time, or a change in the bed height. Another speaker passed around a defective casting which contained a flat spot on the surface opposite the gates. The cause was attributed either to improper molding, sand condition, or pouring temperature, and it was suggested that the mold be set on the floor with the gate end higher than the opposite end, and poured in that position.

Another speaker mentioned a peculiar occurrence observed in pouring an iron which had been covered by a carbide slag in an electric furnace. The iron lacked fluidity, but when a shovelful of mill scale was thrown into the bath, the metal recovered its fluidity, and could be poured into thin sectioned castings. That peculiarity parallels a similar condition which sometimes occurs in melting steel in the electric furnace, and which has been termed over-reduced steel.

Talk on Many Phases

After an informal luncheon, several sessions were held, including a round table discussion on steel foundry problems under the direction of D. P. Spencer, Racine Steel Castings Co., Racine, Wis.; a lecture on core binders by J. A. Gitzen, Linsay-McMillan Co., Milwaukee, and a laboratory demonstration on metallography conducted by D. E. Krause. In the session on steel foundry problems one speaker asked the cause of pinholes which occurred after annealing steel castings. Several were suggested including the method of gating,

mold condition, and pouring temperature. It was concluded that castings should be poured at a definite temperature, or the sand condition corrected to take care of a higher pouring temperature. Another speaker stated that pinholing in a few castings had been the result of wet mud placed on the spout of the ladle prior to pouring the castings.

In discussing core binders Mr. Gitzen stated that experiments indicated that excess moisture in oil sand mixtures was responsible for sticking to core boxes. Several foundries use dry sand with oil to eliminate that trouble, and to obtain fine surfaces on the cores. He also stated that hot water added to sand before the oil resulted in higher tensile strength in the cores. With cold water no difference was observed whether the oil or water was added first. Off grade core oils containing considerable foots may form sticky characteristics. These may be eliminated to some degree by the addition of paraffine oil. Mr. Gitzen stated that specifications could be drawn for core oils, but that all tests, such as iodine and saponification numbers, acidity, etc., should be considered.

A. A. Grubb, Grubb & Marshall, Columbus, 0., in a talk on clay binders for foundry sands stated that a relation exists between particle size of the clay and the dry bond strength, and that the finer the size, the greater the strength. He mentioned that bonding clays vary considerably in the temperature at which the water of combination is lost. That factor has a relation to green bond strength in that the higher the temperature at which the water is lost, the longer it retains its green bond strength.

Excess Clay Causes Trouble

He also called attention to the fact that excess clay in the molding sand may cause trouble. In addition to needing more water to make the sand workable, excess clay has a tendency to hold sand grains apart, and hence leaves larger openings for metal to penetrate between sand grains. Mr. Grubb stated that dry bond strength of molding sand has so many variables in its determination that it sometimes is difficult to interpret the results, and for that reason advocated that the old *feel* test be applied in addition to the dry bond test.

Sessions held Thursday morning included a lecture on the cupola by Prof. McCaffery; a discussion of the heat treatment of steel castings under the direction of J. Fletcher Harper, Allis-Chalmers Mfg. Co., Milwaukee, and laboratory demonstrations of physical property determinations on iron and steel by Prof. Oesterle. Prof. McCaffery stressed the importance of volume and pressure indicators in cupola operation, and stated that in his opinion a soft dolomite will be a better fluxing agent than limestone as it has better desulphurizing properties. He also said that the foundryman should know the effects of silicon and carbon on gray iron, and mentioned that higher silicon, lower carbon gray iron has a narrower freezing range than a lower silicon, higher carbon iron. Prof. McCaffery stated that when the cupola is botted up the iron tends to pick up silicon due to the reducing conditions present which react upon the slag.

In the session on heat treatment of steel it was pointed out that to relieve strains in castings, they should be heated slowly to 1100 degrees Fahr., and then rapidly above that point to the desired range. The latter operation should be performed in about 60 per cent of the time required for the first heating. Badly oxidized steel poured at high temperatures gives a dull flaky structure. The condition is aggravated by low manganese. The molder should be informed when castings are to be heat-treated so that the proper gating may be provided. One instance was cited in which a quantity of wheels were 3/16-inch out of round after heat treatment, and consequently rejected. Change in gating eliminated the difficulty.

Closer Control Is Needed

Those sessions were followed by a lecture on malleable annealing by Prof. Scott Mackay, University of Wisconsin, a gray iron round table discussion under the direction of C. J. Scullin and D. J. Reese, and a laboratory demonstration on inclusions in steel by D. E. Krause. Prof. Mackay stated that the use of the short cycle anneal will depend upon a much closer control of the product. He mentioned that melting and pouring temperatures will affect the structural composition, which will be reflected during the annealing. He also pointed out that considerable misinformation has been published on malleable iron in various textbooks, and suggested that malleable foundrymen exert every effort to disseminate the correct information.

The afternoon session following the informal luncheon were devoted to a round table discussion of steel foundry problems and malleable cast iron. The steel session was directed by C. E. Silver, Sivyer Steel Casting Co., Milwaukee, and included a discussion on the proper method of heat treating a 0.40 per cent carbon, 1 per cent chrome steel to obtain the desired softness. It was suggested that the casting be normalized at 1725 degrees Fahr., air quenched, and drawn at 1300 degrees, or higher in 25 degree steps. It also was suggested that the soaking time be increased before resorting to a higher drawing temperature for the steel.

W. F. Graham, Caskey Brass & Bronze Works Inc., Philadelphia, directed the malleable session which was held simultaneously with that on steel. The discussion brought out the fact that from the engineering point of view, impact resistance was of more importance than elongation. It also was pointed out that yield point and ductility of malleable cast iron should be stressed instead of tensile strength, and that the malleable foundryman should produce the desired structure to fit a particular application. One speaker stated that effort should be made to obtain a better surface condition for machining as with thin cuts, the decarburized skin causes difficulty. Another speaker said that he believed that a longer heat treatment at lower temperature would give better machinability than a more rapid treatment at higher temperatures.

Casts Bronze Door

(*Concluded from Page* 71)

transferring the metal from the furnaces and crucibles to the reservoirs to keep the metal at as near the proper temperature as possible. In addition to quick handling, it was necessary to fill the four reservoirs as simultaneously as possible.

The castings were made from shell patterns. Consequently, there were no cores except for the small false cores which were used around the moldings which were undercut. These cores, made up of a French sand mixture and oven dried, were produced in small sections by the company's statuary molders. Upon their removal they were replaced on the pattern where they served as a drawback. All of the larger castings were poured late in the day so that they could be allowed to stand overnight. However, within a half hour or so after their pouring, the molds were released sufficiently to allow for contraction.

The door was finished in natural bronze. Each casting was dipped in an acid solution and then gone over with portable grinders, equipped first with rough carborundum wheels and then with No. 60 carborundum rag wheels. Owing to the various decorative features, however, it was necessary to do much finishing by hand. The hand operations consisted of filing, chasing and polishing. Assembled each wing weighed 10 tons.

Vice Presidents Elected

E. S. Fickes, G. R. Gibbons, and R. E. Withers recently were elected senior vice presidents of the Aluminum Co. of America, Pittsburgh, at a meeting of the board of directors. Harwood Byrnes, S. K. Colby, W. C. Neilson, G. J. Stanley, P. J. Urquhart and I. W. Wilson were elected vice presidents at the same meeting.

BONDS *Fitting Cores* With Cement

By Pat Dwyer

Fig. 1—Iron from a Skimming Spout Falls First into a Reservoir Ladle and Then to the Pouring Ladle

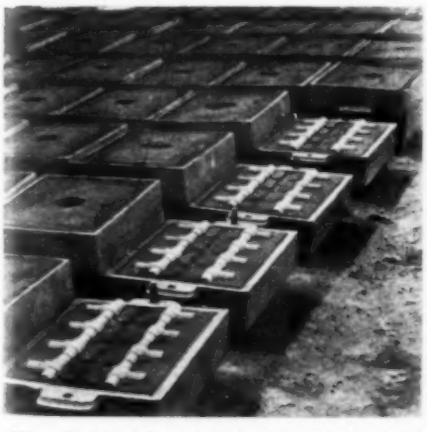
IN LINE with a general policy of expansion, referred to at some length in THE FOUNDRY, Jan. 15, 1927, the Walworth Co., Boston, acquired a plant formerly operated by the National Pipe & Foundry Co., in Attalla, Ala. This town located on the main line of the Southern railroad between Chattanooga, Tenn., and Birmingham, Ala., and also served by two other railroads, is in a favorable position for the distribution of the company's products in the South and Southwest. This is particularly true of a new type of small diameter alloy cast iron pressure pipe, welded in 20-foot lengths and placed in the oil, gas and steam field in competition with fabricated steel pipe.

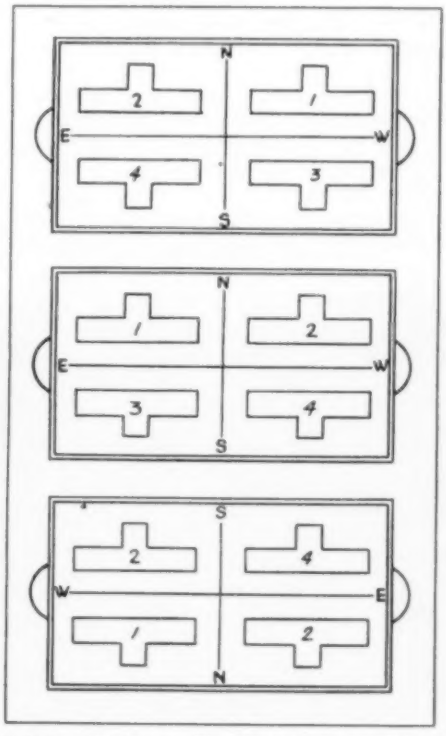
It is claimed that this new cast iron pipe is much stronger than ordinary pipe and will resist corrosion better than steel pipe under most conditions. It is shipped out in 20-foot lengths made up of four sections welded at the ends, or, in single sections threaded on the outside of both ends and assembled in any desired length in the field, by couplings.

The plant, on a small scale was built in 1917, burned down a year later and rebuilt on a somewhat larger scale. It has been extended on various occasions both before and since its acquisition by the Walworth Co. in 1925. Auxiliary buildings have sprung up here and there to cope with enlarged activity, but the foundry building has been extended on each occasion by knocking out one of the end walls and extending the roof and side walls the required distance to build the project.

At present the foundry is approximately 150 feet in width and 300 feet in length. Rows of columns on 20-foot centers support the roof and various monorail lines and also divide the floor area into 15 bays, four at one end for the steam fittings, eight in the center for soil and pressure pipe and 3 at the other end for soil pipe fittings. A wide gangway extends along one side from one end of the shop to the other and a central gangway extends through the center of each bay at right angles to the main gangway. The molds are set up in rows on both sides of the central gangways. Ample light is supplied through a continuous window in the side and end walls, also windows in the monitor roof which extends over the center of the building from end to end. The normal daily production of castings is 45 tons.

A dry sand core department without ovens and where cement is the only core binder employed, occupies a space close to the south end and





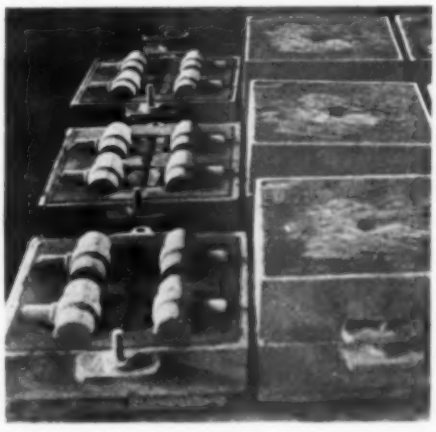


Fig. 2 (Left)—Molds Are Made in Stiff Iron Flasks. Fig. 3 (Center)—Diagram Illustrating Use of the Match Plates. Fig. 4 (Right)—Each Casting Is Gated at Both Ends

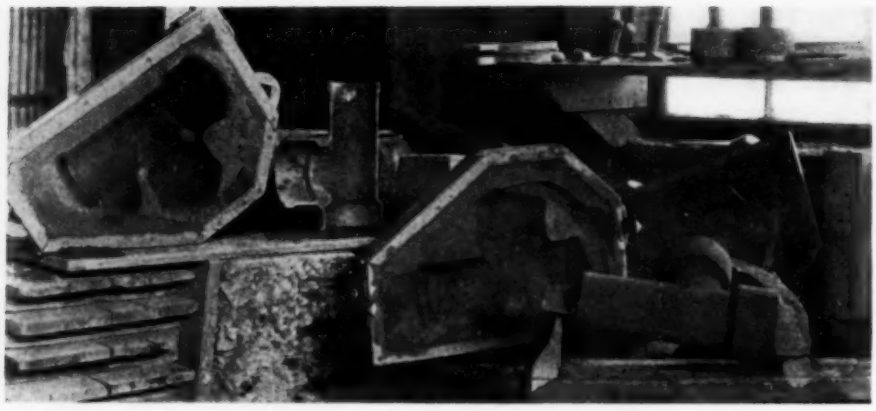


Fig. 5—Mold and Core for This Casting Are Molded Simultaneously in Green Sand from a Split Pattern

extends along the west side of the foundry. The cupola department is on the same side of the building about midway from end to end. The sand storage sheds are located in the yard outside the core department and the stockyard for cupola supplies occupies the space outside the cupola room and extends to the railroad.

Watch the Sand

Several grades of local sand are utilized for making the molds. The castings range in size from ½-inch to 16-inch fittings, from 2 to 8-inch soil pipe and connections and from 2 to 8-inch pressure pipe in 5-foot lengths. Many diverse conditions obtain in such a wide miscellany. For that reason the molds are segregated into groups and the sand for each group is maintained at a definite standard in regard to bond, permeability and moisture content. The sand is cut over at night by a labor gang in charge of an expert sand man who decides how much and what species of new sand is to be incorporated in each sand pile on the floor.

Typical examples of how the small steam fittings are molded are shown in Figs. 2 and 4. The patterns are grouped in such a manner that the flask will not impose too great a lifting strain on the molder. Thus it will be noted that four units constitute a group in the mold shown in Fig. 4, while twice that number are grouped in the mold shown in Fig. 2. The first is a mold for 1 x 2-inch screwed Tees while the second is a mold for 1 x 1-inch connections of the same kind.

Some of the patterns are split in the center and mounted on both sides of the pattern plate. Others, and these are in the majority, are split in the center, but are mounted only on one side of the plate. However, they are arranged definitely in relation to 2-right angle lines so that the two parts of the mold will coincide when the cope is placed on the drag. In practice a number of half molds are made and placed on the floor to serve as drags. Naturally in lifting them from the pattern plate and placing them on the floor face up, they are rolled over, or inverted either on an imaginary longitudinal or transverse axis.

A cope rammed on the same plate is not rolled over therefore it is apparent that the mold cavity in one corner of the cope will come above the mold cavity in the opposite corner of the drag. This feature is illustrated in the outline sketch Fig. 3 where the center represents the pattern plate, face up, and the patterns numbered from 1 to 4.

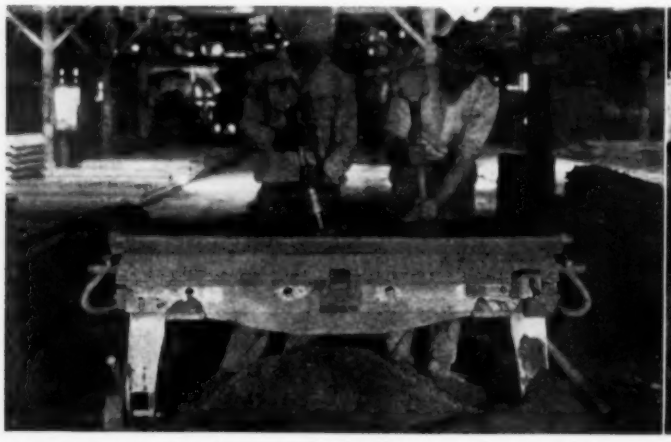
A drag lifted from this plate and rolled over on the axis *N S* would show the mold cavities in the position indicated at the top. A drag lifted and rolled on the axis *W E* would present the cavities as in the lower figure. The points *N* and *S* do not change position, in the first instance but the *W* and *E* change places. In the second instance the ends *W* and *E* do not change places but the sides *N* and *S* change position.

Thus if a cope is rammed on the plate in the center and then placed on the drag as shown at the top, the mold cavity 1 will come over 2, 3 will come over 4, 2 over 1 and 4 over 3. If the same cope is placed on the drag as shown at the bottom, 1 will come over 3, 2 will come over 4, 3 will come over 1 and 4 will come over 2.

Miscellaneous Fittings Made

One bay is devoted to the production of large miscellaneous fittings. The equipment and methods do not differ materially from those employed in a jobbing foundry where only one, or at best a small number of castings are ordered from any given pattern. The remaining bays in the steam fittings department are equipped with molding machines of various types made by the Osborn Mfg. Co., Cleveland, the Herman Pneumatic Machine Co., Pittsburgh; and Wm. H. Nicholls Co., Richmond Hill, Long Island, N. Y. On some of these machines the patterns are dropped through stripping plates, on others the mold is lifted away from the patterns and on others the mold remains stationary while the pattern either is lifted up or lowered away from it.

Light electric hoists span those bays in which the flasks are too heavy to be lifted by hand. Most of the cores employed in this section of the foundry are made of sharp sand bonded with cement and air dried. In some instances green sand cores are employed and in others a combination dry sand bottom and green sand top has been found advantageous. A dry sand core is an insurance feature and therefore is favored in castings destined for high pressure service.



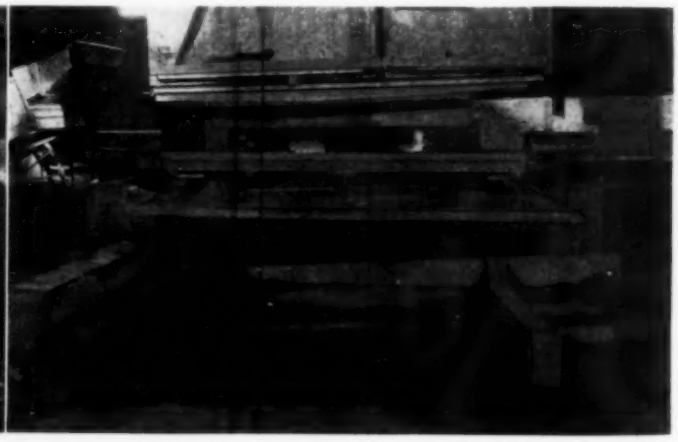


Fig. 6 (Left)—Typical Setup on Which Soil Pipe Molds Are Rammed by Hand. Fig. 7 (Right)—Green Sand Cores Are Swept on a Modified Type of Lathe

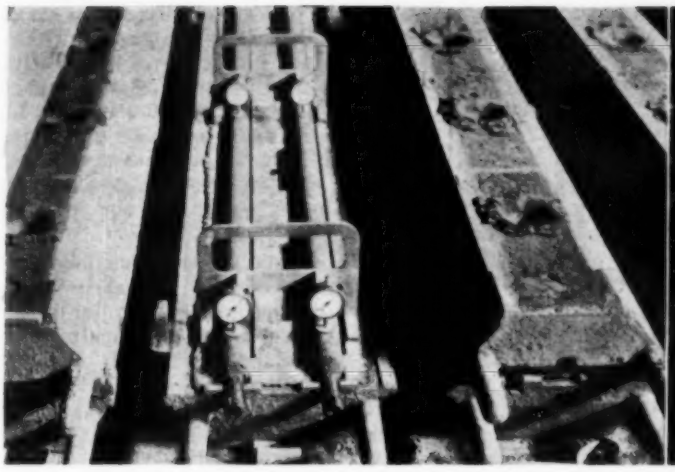


Fig. 8 (Left)—On Pressure Pipe the Cores Are Set by Gages. Fig. 9 (Right)—Molds Are Arranged in Long Straight Rows Under Monorail Lines Which Carry the Ladles

Green sand cores exculsively are placed in the molds for soil pipe and soil pipe fittings. The straight lengths are swept on core barrels while the cores for the connections, elbows, bends, Ys, Ts, crosses, etc., are made according to two methods. In the first the pattern serves to make both mold and core. In the second the core is made independently and placed in the mold after the pattern has been removed. The first method is subject to farther subdivision. In one method the mold is rolled over twice and the core is not moved at any stage of the process. In the second method the core is lifted out of the mold to permit the removal of the drag half of the pattern. Then the core is returned to place in the mold.

Pattern Forms Core

A typical pattern mold and core of this kind are shown in Fig. 5. The cast iron pattern is an exact replica of the desired casting, with the exception that it is split longitudinally through the center, is provided with dowel pins, is highly finished and is slightly larger than the proposed casting to compensate for the anticipated shrinkage.

The drag half of this pattern is placed on a follow board and the drag is rammed and rolled over in the usual manner. A small quantity of sand is placed inside the pattern and the cast iron core arbor is pressed down into place. The second half of the pattern then is adjusted after

Fig. 10—Green Sand Cores Are Supported on Special Plates Until They Are Dried

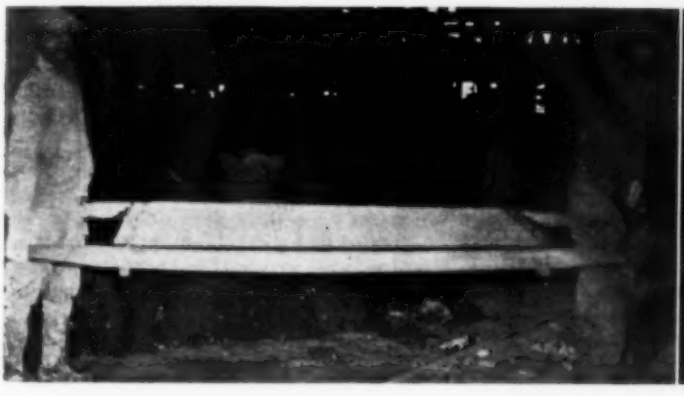
which sand is packed into the pattern through the openings. The cope is rammed and lifted off. The top half of the pattern is removed. The core is lifted out and placed on the stand as shown in Fig. 5. The drag half of the pattern then is removed after which the mold is reassembled.

In the other method, drag, core and cope are rammed as in the preceding instance. Then the entire mold is rolled over so that the cope rests on the bench. The drag is lifted off and the drag half of the pattern is removed from the core. Then the drag is replaced and the entire mold is rolled back to its original position. The cope is lifted off and the cope half of the pattern removed from the core. The cope then is replaced.

The adoption of either method depends almost entirely on the shape and size of the casting. The method outlined last is particularly adapted to short, chunky castings in which the core will stand without an arbor, or with an arbor of the plainest and simplest description.

Coreboxes Are Described

Where the molds are made on machines the cores are made in coreboxes and *booked*. The two halves of the corebox are hinged to each other. The arbor is placed in the drag half. Sand is packed by hand in both halves and scraped off flush with the edges. Both halves are raised to a vertical position until the sand faces touch each other. Then the assembly is lowered back on the bench with the drag side underneath. The cope half of the corebox is



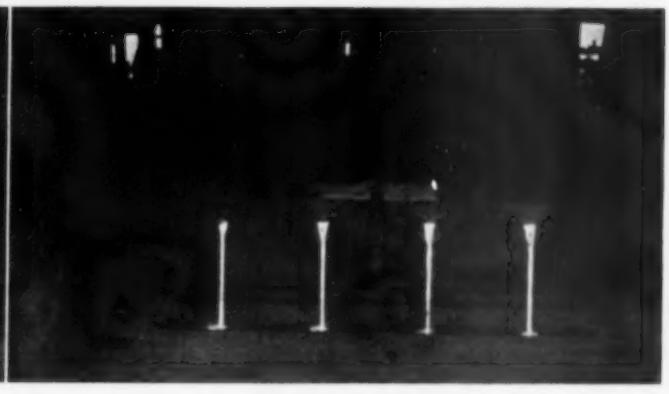


Fig. 11 (Left)—Green Sand Cores Are Carried on Special Hand Barrows To the Molding Floors. Fig. 12 (Right)—Multiple Lip Ladles Are Employed To Pour the Iron

swung back on the hinges, the core is lifted out of the drag half and placed in the mold.

Soil pipe patterns up to 6-inches diameter are mounted in pairs on the type of movable bench shown in Fig. 6. Larger sizes are mounted singly on similar machines. The patterns are mounted in such a manner that they may be dropped a short distance through the top plate before the mold is removed. This insures a clean lift. The device is mounted on wheels which travel on paths provided for the purpose and covered with iron plates one foot in width. The machine follows the receding sand pile from one end of the floor to the other and the molds are laid down in a straight row in its wake. The iron plates serve as guide to keep the molds in line, a necessary feature later when the ladle suspended from a monorail moves over the center line of all the molds on the floor.

The men work in pairs. The sand is shoveled and rammed by hand and the same men lift all the flasks and close the molds. A separate gang pours the iron, shakes out the castings, stacks the flasks, removes the castings and prepares the sand. One man makes the cores for seven floors, and four men distribute and set them.

One of the core making machines is shown in Fig. 7. A bucket type elevator lifts the sand and discharges it into a hopper provided with a narrow orifice about 12 inches above the core barrel mounted in a modified type of lathe. The sand falls in a thin stream on the revolving barrel and a stationary strike develops the outside contour of the core. As fast as the cores are made they are loaded on hand barrows and taken to their destination as shown in Fig. 11.

At the Walworth, Attalla, plant dry sand cores are made on three machines made by Wm. Demmler & Brothers, Kewanee, Ill., and the employes are not forced to handle the sand to any extent. Cement in the proportion of 1 part cement to 10 parts sand, by volume, is added to a species of sharp sand that carries a small amount of natural bond. The mixture is prepared in batches in a sand muller made by the National Engineering Co., Chicago and then riddled before it is loaded into the magazines of the core blowing machines. Under normal conditions the three machines with their operating crews on a single shift can keep up with the daily production in the foundry of approximately 10 tons of miscellaneous fittings.

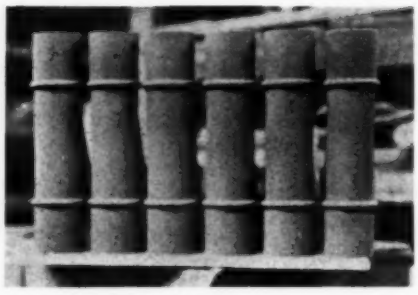


Fig. 13—Back Views of Cores Shown in Fig. 10

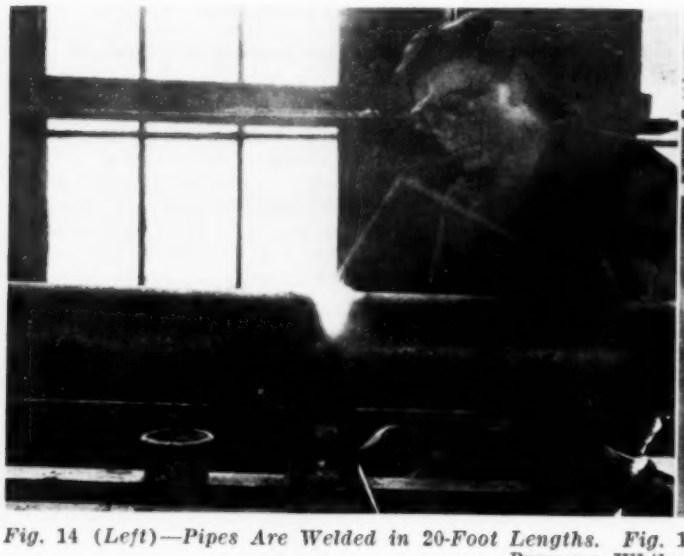
Cores made from the foregoing mixture are strong both in the green and in the dried state. They are taken from the coreboxes and placed on plates where they retain their shape without distortion or sagging. Typical examples of green cores ready to be put away on the extensive rack shelves, are shown in Figs. 10 and 13.

After a period of 24 hours the cores are fit for use. They are hard and dry and remain that way indefinitely. It is claimed that cores stacked away on the shelves for a year or more have been utilized upon occasion with perfect satisfaction.

Three cupolas are available for melting the iron. One is lined to 45 inches and is used for melting the iron for the high pressure castings. Each of the other two cupolas is employed on alternate days for melting the iron for the soil pipe and fittings. A typical charge of 1000 pounds for the small cupola is made up 60 per cent pig iron, 30 per cent scrap iron, 10 per cent steel scrap, 2½ pounds nickel and 2 pounds 80-per cent ferromanganese.

The cupola charges are made up on trucks running on narrow gage tracks in the yard. Two elevators carry the trucks to the charging platform provided with two transfer tracks by which the loaded cars may be switched to the front of any of the three cupolas, and the empty cars may be returned to the elevators. Component parts of the charge for soil pipe vary to some extent depending on market conditions, transportation and other features. Materials are charged to yield the following approximate analysis: Silicon 2.50 per cent, sulphur 0.90 per cent, phosphorus 0.73 per cent and manganese 0.70 per cent. All the borings and turnings from the machine shop are packed in sheet iron containers and are utilized as part of the cupola charge.

Castings are cleaned in separate buildings at both ends of the foundry. Some of the tumbling barrels are home made and some of them were supplied by the W. W. Sly Mfg. Co., Cleveland. The machine shop is equipped with special machines, automatic or semiautomatic in which the castings are tapped, threaded, bored, faced or otherwise subjected to the necessary degree of finishing at an exceedingly rapid speed. The straight lengths of high pressure pipe are ground at both ends and then either threaded or welded, depending on whether they are to be shipped in short or long sections. Each section is tested with air pressure under water. Both the electric and acetylene methods are employed in the welding shop.



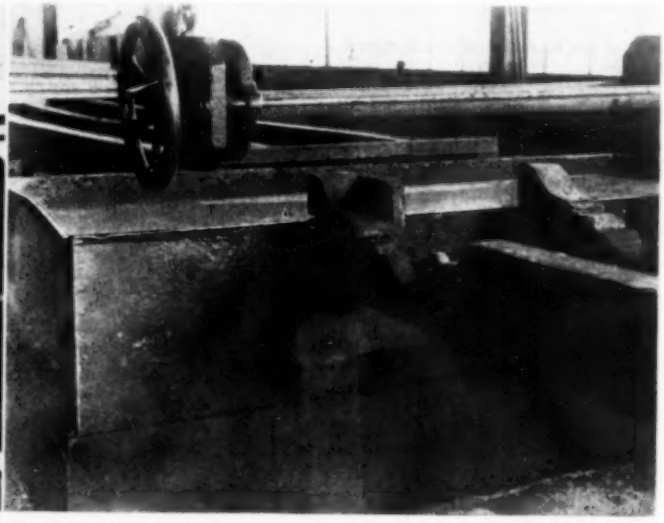


Fig. 14 (Left)—Pipes Are Welded in 20-Foot Lengths. Fig. 15 (Right)—Each Pressure Pipe Section Is Tested With Air Pressure While Under Water

Successful Safety Programs

Depend Upon Three Factors

By R. F. Thalner

THREE major factors must be dealt with in treating the subject of accident prevention. Those factors are management, men, and foremen. Each has its various subdivisions and contributing factors which affect the welfare of a safety program.

The most important factor in the success of a safety program is the attitude of the management. Management's consent should not be that type which is half sold and says, "Yes, go ahead. See what you can do." It must be that consent which comes from being sold 100 per cent on the idea of such a program; that consent which comes from knowing that reduction of accidents will bring about a better morale and attract a better type of workman; that consent which comes with the knowledge that such a program is of economical benefit to employe and employer alike; that consent which says, "We are interested vitally and want to see this program through, and to that end pledge our complete support."

Enthusiasm Is Necessary

Definite policies set up by the manager and his staff with regard to the plan of accident prevention, must be carried out enthusiastically. The minute that management loses its enthusiasm and fails to carry out policies which it has set up, just that soon accident rates will increase and the activities of the safety program enter into the waning stage.

After policies are established, another factor of much importance which is based on the psychology used by all good salesmen, enters into the picture. The salesman who wants to sell a new car will demonstrate with one that is clean, well kept and performs properly. The salesman follows that method because outward visible expressions have the desired effect of helping to win a favorable opinion in the mind of the proposed customer.

A similar situation exists in the shop where a program of accident prevention is to be launched. Machines and equipment need guarding, and probably other conditions should be changed. Management must demonstrate to its employes that it is behind such a program. No better method can be employed than protecting dangerous machines and equipment and remedying conditions in general.

Buildings should be constructed lighted and ventilated properly so employes are given every possible protection, not only from the hazards of machines, tools and equipment, but also from conditions which tend to impair or break down their general health. The installation of protective appliances and other changes, promoting healthier and more sanitary working conditions, become as effective as silent salesmen because they constantly remind the employe that the management is behind the program.

Management having thus signified its intention to prevent accidents can effectively enlist the aid of every man in the shop because their support of the program is of paramount importance. The men must use the mechanical guards and devices that have been installed for their protection, if any benefit is to be derived from safety device installations. Men, in addition to being apprised of the intentions of the company to enter into a program of accident prevention, must be given a certain amount of specific information which will aid them to do their work in the safest manner possible.

An employe undoubtedly will be willing to lend support but can only do so in a limited way because he has no general knowledge of hazards of the shop. To perform the work he is hired for, whether it be productive or nonproductive, he is supplied with tools, machines and other equipment. The manner in which he uses those tools and machines, determines the quality and the quantity of the work he produces. Likewise, he must be supplied with the tools of safety, some of which are the educational or instructional features of the program.

Hazards Are Listed

A safety rule book is nothing more than a set of tools which will enable the employes to perform the various operations in the program of accident prevention. It is important that the actions of the employes be standardized as much as possible so that the effect of the application of the safety rules will be most beneficial. General hazards should be listed so that men will be informed, regardless of the locality in which they are working. Specific hazards and rules can be compiled for departments whose hazards are confined to a particular class of work.

The employe also can be informed of safe and unsafe practices by the employes' publication which is an excellent medium to disseminate information because it offers an opportunity to use photographs, charts, and printed material, in a form that cannot be used in poster work.

The use of posters and signs can be employed for promoting safety among the employes, and is another important part of the program because in the poster a short snappy message is given which can be digested readily. Photographs, are used extensively be-

Each Must Help

CO-OPERATION between the management, employes and foremen is necessary for the successful operation of an accident prevention program. The management must be sold thoroughly on the project before it is attempted and wholehearted support is essential. Educational methods on the part of the management are necessary to teach the men the value of safety, with the foremen becoming the connecting link between the management and the employes. He should be taught the value of safety and must be equipped to teach employes its value. This article, describing the various factors that must be taken into consideration in launching a safety program, is abstracted from a paper presented at the recent annual meeting of the National Safety council in Pittsburgh. The author is safety director, Buick Motor Co., Flint, Mich.

cause so much education is received through the eye. The picture method also has its advantages over the printed poster because all nationalities and races are able to understand a message portrayed by picture. Signs can be used as a means of calling attention to certain specific hazards, to rules which must be emphasized specially, and to certain policies which must be stressed.

Another method of educational value is that which comes as a result of activity in committee work. Acting as a member of a safety committee and contacting with senior members of that committee, gradually will bring knowledge to new members as a result of inspection tours.

The foreman is supplied with machines, materials, and men. With the proper combination of those items, he arranges the manufacture of a certain product. He is held responsible for the machinery and sees that it is operated and cared for properly, and does not become damaged or broken. He exercises the same care to see that the material which comes to him is worked properly with the least amount of scrap. In addition to instructing his men on how to operate a machine and care for it, the foreman should tell them of the inherent hazards of the particular machine and of handling materials.

Foreman Watches Department

Any foreman who is efficient and is desirous of getting the largest production at the lowest possible cost constantly must scrutinize his department to see that nothing is wasted. Broken tools, scrapped material, damaged equipment and preventable accidents enter the waste column. This last item of accident cost is not the actual cost because a study by one large insurance company shows that the total cost of an accident to any corporation is about four times the actual medical and compensation cost. If that is true, any foreman who has accidents in his department is permitting his waste item to mount constantly and is allowing his department to become inefficient. The foreman is the manager of his department. He is held accountable for all the scrap produced in that department and the machinery and tools that are damaged. He also should be held responsible for the accidents in his department.

If that responsibility is to be placed on the foreman, management should give him some aid by taking him into its confidence and by giving him instructions and educational material to try and make him a better foreman. It seems necessary that when management expects these duties of a foreman, management should in turn see that he is given proper instruction or education to better fit him for his work.

The safety engineer is of invaluable aid in giving instruction and preparing special educational material for foremen. Records of accidents, showing frequency and severity should be prepared by him and given to the supervisory force. They also should be informed on the cost of accidents so that the superintendent can determine which departments are incurring excessive costs. Compilation of rules and regulations, for and with the approval of the foreman, will give a set of standards by which the foreman can be guided in instructing his men. Special meetings in which discussion on subjects prepared by the safety engineer can be taken up are valuable.

Has Valuable Properties

(*Concluded from Page* 74)

their results published in *Die Giesserei*, Feb. 3, 1928. Tests were made at various temperatures from room temperature to about 200 degrees below zero Fahr. Tests on five different mixtures with 40 bars to each mix were made. These tests confirm the earlier research referred to above, and indeed indicate a distinct tendency for increases in tensile strength at lower temperature for some grades of iron. There also was some tendency for increase in brinell hardness. However there is some decrease in impact value at temperatures 112 degrees below zero Fahr. and lower. It is concluded that no serious diminution in properties occurs in cast iron at the lowest temperatures reached in average climates. Those designing apparatus for low temperature service conditions should bear in mind thermal contraction and its consequent internal stresses which likely may be encountered at lower temperatures just as designers should take into account expansions encountered at elevated temperatures.

This is the fourteenth article of a series on the engineering properties of gray iron. The thirteenth article appeared in the Feb. 1 issue and the fifteenth will appear in an early issue.—THE EDITORS.

S.F.S.A. Elect Officers

At the meeting of the Steel Founders' Society of America held in Cleveland, Jan. 28-29, the following men were elected officers of the large and small castings divisions of the society: LARGE CASTINGS DIVISION, T. H. Harvey, Ohio Steel Foundry Co., Lima, O., chairman and W. E. Trump, Machined Steel Casting Co., Aliance, O., vice chairman; SMALL CASTINGS DIVISION, Clarence Tolan Jr., Dodge Steel Co., Philadelphia, chairman, vice chairman to be elected at the next meeting.

Each division also elected program committees. That committee of the large castings division consists of W. E. Trump, Machined Steel Casting Co., Alliance, O.; G. B. Wadlow, Hubbard Steel Foundry division, Continental Roll & Steel Casting Co., East Chicago, Ind., and R. A. Cannon Birdsboro Steel Foundry & Machine Co., Birdsboro, Pa. The program committee of the small castings division is as follows: Eastern division H. C. Cunningham, Crucible Steel Casting Co., Lansdowne, Pa. and G. R. Casey, Treadwell Engineering Co., Easton, Pa.; Central-Atlantic division, Frank D. Glosser, Commercial Steel Casting Co., Marion, O.; William J. Corbett, Fort Pitt Steel Casting Co., McKeesport, Pa. and Ralph F. Tillman, Industrial Steel Casting Co., Toledo, O.; Midwest-Southern division, Martin Fladoes and L. S. Peregoy, Sivyer Steel Casting Co., Milwaukee and W. J. Donnelly, George H. Smith Steel Casting Co., Milwaukee.

T. R. Heyward, Duraloy Co., Pittsburgh, was re-elected chairman of the heat-corrosion resistant alloy founders division of the Steel Founders' society.

Nonferrous Foundrymen Form Association

Connecticut Nonferrous Foundrymen's association has been organized and has been meeting at the Hotel Garde, New Haven, Conn., on the second Monday each month. Meetings consist of a dinner, business session and a round table discussion. George Belknap, Belknap Mfg. Co., Bridgeport, Conn., was the speaker at the Jan. 12 meeting. He discussed melting costs and furnace operations and was assisted by Dave Tamor, metallurgist, Reading Steel Casting Co., Hartford, Conn.

Henry Spencer, Lombard & Co., Boston, addressed the Feb. 9 meeting on "Grinding Wheels and Abrasives." The speaker at the March 9 meeting will be a representative of the New Haven Sand Blast Co., New Haven, Conn., who will talk on the application of sandblasting to nonferrous foundries.

Considerable interest has been shown and the attendance at each meeting has averaged about 30. Officers for 1931 are: C. H. Blanchard, Reading Steel Casting Co., Pratt & Cady division, Hartford, Conn., president; George Belknap, Belknap Mfg. Co., Bridgeport, Conn., vice president; C. D. Elliott, Wilcox, Crittenden Co. Inc., Middletown, Conn., secretary; and H. A. Phelps, Phelps Foundry Co., Ansonia, Conn., treasurer.

Charles G. Jurack, formerly with the Milwaukee Foundry Equipment Co., Milwaukee, has become connected with the Chain Belt Co., Milwaukee, in the foundry equipment division. He will supplement the foundry engineering activities of the company and will have headquarters at the West Milwaukee works.

The FOUNDRY Family Photograph Album

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Upper Left

W. M. CARTY

Standard Brake Shoe & Foundry Co., Pine Bluff, Ark.

Upper Right

W. H. LUDINGTON

Air Reduction Sales Co., New York

Lower Left

E. W. BEACH

Campbell, Wyant & Cannon Foundry Co., Muskegon, Mich.

Lower Right

E. H. CORNELIUS

Oklahoma Steel Casting Co., Tulsa, Okla.

REGULATIONS FOR THE INSTALLATION OF

PULVERIZED FUEL SYSTEMS

(Continued from Data Sheet No. 850)

PIPE LINES—SPECIFICATION NO. 2

26. The wall thickness given in Table II are the minimum requirement with 12½ per cent added to cover the usual mill tolerances.

PIPE LINES—SPECIFICATION NO. 3

27. Pipe shall be standard full-weight steel. Flanges and fittings shall be A.S.A. standard B (16a) (125 pound Standard).

STORAGE AND FURNACE BINS

28. (a) Storage and furnace bins for pulverized fuel shall be located as far as consistent with operating requirements from furnaces, and away from open flames or open lights of any kind. Bins shall be so located and constructed that no radiation from furnaces, boilers, steam pipes or flues, or other heating appliances, can materially raise the temperature of the contents of the bin.

(b) All bins shall be of non-combustible material so constructed as to present a smooth surface on the interior, and so shaped that a minimum of material will be left in the corners under normal emptying operation of the bin. Material used in construction of metal bins shall be steel of sufficient thickness to secure ample mechanical strength. Joints shall be riveted and caulked or welded; size and spacing of rivets shall be such as to secure a dust tight joint. Dust tightness shall also be secured in cases where metal bins are lined with concrete or where bins are constructed of concrete.

(c) Except for vent openings, all storage and furnace bins shall be normally tightly closed. When bins are filled by transferring pulverized coal by means of air, either under pressure or by a fan, the arrangement should be such as to assure a minimum dust cloud within the bin. Such vent

Table II

PIPE DIMENSIONS 50 POUND WATER PRESSURE

Nominal Pipe Size (inches)	Wall Thickness (inches)
4	0.133
5	0.135
6	0.138
8	0.147
10	0.154
12	0.162
14 O.D.	0.169
16 O.D.	0.177
18 O.D.	0.186
20 O.D.	0.194
24 O.D.	0.210
30 O.D.	0.234
36 O.D.	0.258
42 O.D.	0.282
48 O.D.	0.306

openings shall be equipped with tight-fitting dampers or checks to prevent entrance of air from the outside.

(d) All bins should be equipped with a reliable indicating device to warn the operator before the bin is in danger of overflowing without exposing the contents. At no time shall there be any pressure other than that caused by the weight of the fuel in any pulverized fuel storage bin.

IGNITION

29. For purposes of fuel ignition or supplementary use, fuel oil, natural gas or artificial gas may be used if installed in an approved manner.

30. Every coal conveying line shall be located away from all open flames or open lights of any kind and at a safe distance from sources of radiated heat such as furnaces, ovens, boilers, boiler settings, etc.

(Continued on Data Sheet No. 852)

REGULATIONS FOR THE INSTALLATION OF

PULVERIZED FUEL SYSTEMS

(Continued from Data Sheet No. 851)

CLASS A SYSTEMS—SPECIFIC REGULATIONS

FIRE PROTECTION

31. Every building or room containing the foregoing processes shall be provided with approved fire extinguishers in such quantity and of such type as outlined in the Regulations for First Aid Fire Appliances. Wherever the introduction of combustible material into the pulverizing room makes automatic sprinklers necessary for fire protection, their arrangement and control shall be approved by the inspection department having jurisdiction.

All raw coal driers shall be provided with means of introducing live steam or inert gases controlled by readily accessible, quick acting valves.

Means should be provided to divert the contents of these driers to the outside of the building in case of emergency. (See Section 51 (b).)

Note.—Attention is directed to the fact that warning of the overheating of bearing in dusty and inaccessible locations, and when the heating of bearings may cause explosions, may be obtained by the use of approved journal alarms.

TRANSPORTATION PIPE LINES

32. All pipe lines for transporting pulverized coal between mill bins and points of consumption or storage shall be at least equal to the requirements of Section 27, Specification No. 3.

SCREW CONVEYORS

33. Systems using screw conveyors for handling pulverized fuel shall be normally arranged with the driving power applied at the end toward which the fuel is being conveyed. Where the length of transfer is too great for a single screw so driven, any additional units shall be similarly driven and so inter-connected that the stopping of the last screw in the series will automatically stop the others, or as an alternative for such interlocking the junction point between the two screw conveyors shall be placed outside of the building, and be provided with a normally closed spillway or relief valve.

When it is necessary to transport fuel in different directions, and this is to be accomplished by the reversal of motors, the motors operating the screw conveyors shall be provided with overload releases and screw conveyor drives should be provided with shearing pins. All motors driving screw conveyors shall be provided with overload releases.

A solid flooring shall be placed immediately under all screw conveyors to retain any spilled material.

UNIT SYSTEMS

ARRANGEMENT OF SYSTEMS

41. No pulverizer shall be connected to supply more than one furnace at a time. This shall not be construed as preventing the installation of spare pulverizers which may be connected to any of several furnaces if the regular pulverizer is disconnected, i.e., a section of the discharge pipe between the pulverizer and the furnace removed.

42. Piping from mill to burners shall be so arranged that when a mill is in use, all burners which that mill can supply shall be in operation.

43. Two discharge pipes from separate mills shall not be connected to the same burner nozzle.

INSTRUCTION CARDS

51. An instruction card including the following precautions relating to safe operation shall be conspicuously posted in the pulverizing plant, boiler plant and in buildings where pulverized fuel is used.

(a) The use of shavings or other similar light combustible materials for starting fire in drier furnace is prohibited.

(b) The rotation of a revolving drier shall not be stopped while it contains a charge of fuel.

(Continued on Data Sheet No. 853)

THE FOUNDRY DATA SHEET, MARCH 1, 1931

Payment will be made for all contributions on foundry and pattern shop practice suitable for publication

Questions & Answers on FOUNDRY PRACTICE

THIS department covers all problems relating to metallurgical, melting and molding practice encountered in making steel, malleable-iron and gray-iron castings. Questions submitted by bonafide subscribers to this department will be answered by members of the editorial staff of The Foundry, supplemented where occasion requires by the advisory staff whose personnel is as follows:

John H. Hall
Cast Steel

H. A. Schwartz
Malleable Cast Iron

J. W. Bolton
Gray Cast Iron

All questions must be addressed to the Editor, The Foundry, Penton Building, Cleveland.

GRAY IRON

Do Not Blame the Sand

What is the best method for molding and gating piston ring pots from 4 to 10 inches in diameter and 8 inches in length. Is there any special sand used in the foundries where these castings are made successfully in large quantities. What core mixture do you advise for cores 6 inches in diameter and 36 inches in length for sleeves cast on end in dry sand molds through pencil gates. These sleeves are machined all over and must be perfectly clean. The molds seem to stand up, but the cores scale occasionally in the vicinity of the gates.

The method of molding and gating piston ring pots depends to a considerable extent on the number to be handled in any given period. Thus the rig and equipment for handling 1000 of these castings per day would not be at all appropriate for handling one or two dozen. The actual method really is immaterial since these castings are made successfully in the cope or in the drag, gated at the top or at the bottom. They are molded singly, in pairs and in groups of four. Only two features are essential, irrespective of the method and equipment employed. One is absolute cleanliness in the sprue, runner and gate. The other is a mold in which the iron remains perfectly quiet. Usually a close check up on these two points will indicate to the experienced foundryman the necessary changes to adopt. These castings are made all over the country in sands from widely varying deposits. The only requisite is that the sand be sufficiently refractory to prevent *burning in*, and sufficiently open to permit the rapid escape of gas and steam.

To some extent, the foregoing also applies to the 6-inch diameter cores in the long sleeves. Your present core mixture apparently is satisfactory with the exception that occasionally the cores scale in the vicinity of the gates. Without further information we cannot decide if this defect is a wash or a scab. If it is a wash it is apparent the core is lacking in bond. If it is a scab, the core contains too much bond, or it is not sufficiently vented or both. Reduce the amount of bonding material in the core sand mixture, run a 2-inch diameter vent hole through the core, provide a means for the vent to escape readily through the cope and dry the core almost to the point of burning.

Q & A

Metal Contains Alloy

I am interested in making nickel-chrome alloy castings for trucks. What materials are used for alloying and what should be the analysis of the resultant iron?

Several different methods are used for adding nickel and chromium to cast iron. The analyses given for automotive castings vary according to the specifications of the castings buyer. For example one quoted analysis for cylinder blocks gives silicon as 2.30 to 2.65 per cent; maximum sulphur, 0.12 per cent; maximum phosphorus, 0.20 per cent; manganese, 0.60 to 0.80 per cent, and total carbon, 3.20 to 3.35 per cent. This does not give the nickel and chromium content which will vary according to the amount of alloying agent added. In this case the suggested agent was a natural nickel-chromium bearing pig iron and the amount from 6 to 15 per cent in the mixture. This will give approximately 0.06 to 0.15 per cent nickel and about 0.10 to 0.25 per cent chromium.

Another analysis given for automobile cylinders contains 2.00 per cent silicon; 0.60 per cent nickel and 0.35 per cent chromium. The other elements should be in the range previously mentioned. The alloying agent suggested is nickel shot and ground ferrochromium which is added in the ladle. A third method is to add a manufactured alloy containing nickel and chromium to the ladle.

Q & A

Carbon Should Be Low

What would be the effect of increasing the manganese in grate bars to 1 per cent? Will steel scrap additions to the charge improve grate bar castings, and how much should be added? Have you any data available on the use of pitch coke in the cupola for melting iron?

No marked change will be noticed if the manganese in your grate bars is increased from 0.50-0.80 per cent to 1.0 per cent. Growth and scaling deteriorate grate bars, and chromium is the element most effective in ameliorating those conditions. Since additions of steel scrap generally tend to lower the total and graphitic carbon and to increase the combined carbon, their effect may be considered beneficial. The amount practicable to use depends upon the type of grate bars. If they have to be machined, the permissible amount of steel scrap will be lower than would otherwise be the

case. A white iron will resist growth and scaling best, and from a metallurgical viewpoint, high percentages of steel scrap (70 to 90 per cent) may be possible. However, if the bars are thin, it will be found more difficult to run them with the more sluggish, high steel mixtures. Quite often grate bars are made from ordinary iron.

Not much data has been published on the use of pitch coke for melting gray iron. Its high cost and fragility have proved barriers to its application for that purpose. Lately, it is claimed that certain processes have made possible the production of a hard pitch coke which could be used in the cupola. It is said that small percentages of pitch coke (10 to 20 per cent) mixed with the regular coke splits in the cupola, produce a marked increase in temperature of the iron at the spout.

Q & A

Steel Cores Are Used

We are interested in the manufacture of wire drawing dies, and understand that the numerous small holes in the dies are made with graphite cores. Are the cores made by the foundries, or are they supplied by manufacturers of graphite products?

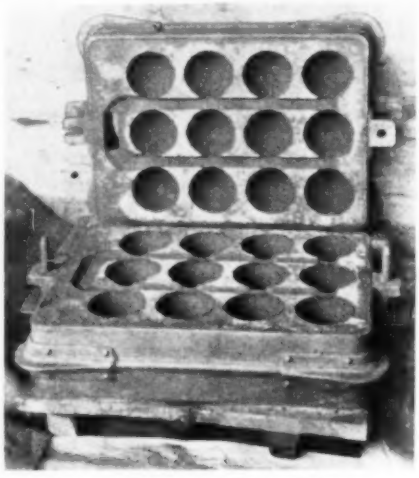
As far as we are aware, wire drawing dies are made from iron that will take a good chill, and they are cast against a chill block at the face of the die, or that portion from which the wire emerges after passing through the die. The cores usually are tapered and are small steel cones. It appears as though a dense grade of molded graphite should be satisfactory for the cores. Undoubtedly, any manufacturers of graphite products should be able to supply you with graphite cones of the desired form.

Q & A

Sand Is Too Tight

We are sending you two grinding balls upon which we would like to have your opinion and suggestions. The balls are made from a mixture of 70 per cent steel scrap consisting of old railroad rails and angle bars or drill steel about 1¼ inches in diameter and 18 inches long; 15 per cent railroad car wheels or old smelter pots, and 15 per cent return scrap. The metal is melted in a 36-inch cupola using 1000-pound charges. The average coke split is 150 pounds. Limerock, 10 pounds; ferrochromium, 9 pounds, and ferromanganese, 6 pounds are added to each charge. The accompanying illustration shows the arrangement of a flask for 3½-inch diameter balls which are molded on a jolt-squeeze, stripping machine. The flasks are 16 x 20 x 5 inches deep. To save floor space, the flasks are stacked two or three tiers high, and offset to permit pouring. We are also sending you samples of the sand used. The balls show pits and shrink holes. How can the appearance be improved? The balls are used in grinding ore and must be hard and tough to wear well without undue breakage.

The specimen balls sent for examination indicate that the metal was agitated from the time it was poured into the mold until it solidified. The exterior skin indicates that the agitation was caused by moisture probably in the form of steam which could not escape from the mold rapidly enough. That also is borne out from the description of your method of molding,



Close Spacing Between Cavities Requires Open Sand

and the samples of sand that you forwarded. The first recommendation we make is that you obtain a much coarser sand than you now are using, or open up your present sand by heavy additions of a fairly coarse grade of silica sand. The bond in your present new sand is extremely high, and considerable silica sand may be added. The more open you can make your sand, the less trouble you will have from moisture in the form of steam, and other gases.

The sand you are using possibly might work if you did not have so many balls to a flask, and if the molds were laid separately on the floor. The former would reduce the quantity of steam formed, and the latter would give it a better chance to escape from the mold. However, if you wish to continue your practice of stacking the molds, you will have to have an more open, permeable sand as mentioned. Also you will obtain better results by placing a steel plate between each two molds. That will prevent the steam from the molds below permeating those above. Vent channels of a reasonable size should be scratched in the underside of the drag, and the top side of the cope. They will aid in carrying gases away from the molds.

The shrink holes you mention are caused by insufficient feeding. To obtain a ball as near round and as solid as practicable, it will be necessary to increase the head of metal. At present you have a head of about 3 inches whereas it should be at least 6 inches. The easiest way to accomplish the increase is to bush the pouring gate an additional 3 inches above the cope.

It appears to us that your iron mixture will be rather low in silicon if you use steel scrap, car wheels, and return scrap. We believe that you will have better results by using 70 per cent steel scrap, 15 per cent gray iron scrap which could be the smelter pots you refer to if they are not all burnt up, and 15 per cent return scrap. We do not believe that the amount of chromium you now are adding is adding much to the abrasion resistance of the balls. To obtain the best results it will be necessary to increase the amount of ferrochromium to about 30 pounds per 1000 pound charge. That will give a chromium content around 1.60 per cent, and of course will add to the cost of the balls.

GENERAL

Iron Chills Are Used

Are the chills used for standard car wheels made of steel or of cast iron, and what are the approximate dimensions of the chills? Have you any information on the actual thickness of a standard car wheel rim?

Chills used for car wheels are made of cast iron. The size will vary to some extent depending upon the weight of the wheel cast in the chill. Heavier chills are used with heavier wheels. The approximate dimensions of the chills will be 4½ x 5½ inches; the 4½-inch dimension being parallel to the tread. Since the face of the tread is tapered, it will be difficult to give the actual thickness of wheel rims, but we believe that they vary from 1⅝ inches for the lighter wheels to 1⅞ inches for the heavier wheels.

Q & A

Core Is Too Heavy

I am faced with the problem of supporting 185 cubic feet of core on a 10-inch white pine cope with sides and ends 2½ inches thick. What is the weight of a cubic foot of rammed sand?

Acording to the *Foundrymens Handbook* a cubic foot of rammed sand weighs 87 pounds. With minor variations this figure will serve for calculating either green or dry sand. In exceptional instances, for example where heavy core irons are used extensively, the figure will have to be revised. As a factor of safety and also as a convenience in multiplying it is customary to use the constant 90 instead of 87. Thus in your instance the weight of the core will be 185 x 90 =16,650 pounds, a little over 8 tons. Without further details, length, width and thickness of the core, it is impos-

sible to say whether a 10-inch white pine cope with sides and ends 2½ inches thick will support it, but we should say not. If the core measures 1 x 10 x 18 feet, 2 x 9 x 10 feet or 3 x 6 x 10 feet the cope is not sufficiently rigid to support it or to resist the pressure when the mold is filled later with metal. By bracing the top of the cope with strongbacks, or rails, you might make it serve, but the practice is risky. Only iron or steel flasks should be employed on large jobs.

Q & A

Borings Are Compacted

Do you know of any process whereby cast iron chips such as lathe turnings can be compressed into solid blocks or pigs for cupola use? We have in mind using up chips from our lathes and drills in this manner.

Several firms are compressing cast iron and steel borings, stampings, etc. into briquets for remelting. Some of the methods employ a cementing binder such as clay water, sodium silicate, portland cement, etc., which is added to the borings and then they are compressed. Other methods do not use any binder, employing only hydraulic pressure to accomplish the formation of the borings into a more or less solid mass that will stand considerable handling.

Several automobile companies compress borings in briquets about 4 inches in diameter and 3 or 4 inches long which weigh about 7 pounds. No binder is used and the pressure employed is 20 tons per square inch. The machine used has a capacity of 50 tons of briquets per 24 hours. Long steel turnings also may be compressed, but before this is done the turnings pass through a machine which chops the long turnings into short pieces.

Q & A

Melt Small Amount

Recently we have been contemplating the production of small gray iron castings in our foundry. Many of the castings are irregularly shaped and in some instances the section is not over ⅛-inch. The work presents many of the problems found in ornamental work. What should be the composition of the mix and what type of furnace should be used to obtain the best results? Orders for this work only amount to between 250 and 500 pounds and this would not justify the operation of even a small cupola.

Since you already are operating a gray iron foundry presumably equipped with a cupola, we fail to see why you are speculating on what type of furnace is required to melt iron for a limited quantity of small, light gray iron castings. If your regular run of iron is too hard for the special castings, you either can charge a few hundred pounds of soft iron near the first of the heat, or, you can add a little powdered ferrosilicon to a ladle of your regular iron before you pour these special castings. Typical analysis for gray iron castings approximately ⅛-inch thick would show silicon, 2.75 to 3.00 per cent; sulphur, under 0.10 per cent; manganese, 0.40 per cent, and phosphorus, 0.40 to 1.00 per cent. Under ordinary conditions the mixture would be made up of pig iron and scrap on a 50-50 basis and of course the iron must be melted exceedingly hot.

Q & A

Heat Relieves Strains

We are enclosing drawing of a gas fired heater combustion unit approximately 2 x 4 feet, 3/16-inch thickness of metal and weighing 325 pounds. We are considering the problem of heating these castings to remove all contraction strains and will appreciate your opinion on the proper temperature, length of time to hold them at maximum temperature and whether and to what extent this treatment will remove strains and render the castings immune to cracking in service.

Heat treating castings is practiced to a considerable extent under certain conditions, but we doubt if it would be of any practical benefit in your case. The drawing shows a fairly well proportioned casting and one that is not subjected to any undue strain during the cooling period. If the present castings crack in service it is evident that the composition of the iron is not suitable. Castings resembling yours in general features are made by the radiator people regularly without any trouble and without any after treatment. In the event that you intend to heat treat some of your castings you probably will derive the greatest benefit from heating the casting to a temperature of 1000 degree Fahr., and then allowing it to cool very slowly. This treatment is applied with beneficial results to automobile pistons which correspond closely in metal thickness with your heater sections.

Q & A

Wheels Chill in Hub

When we pour a mixture designed to produce a heavy chill in our mine car wheels, we find that the cored hub is too hard to machine. The metal appears to be chilled. Do you know of any material or method that will prevent the cores from chilling the metal in the hubs?

So far as we know there is no core coating material that will affect the composition of the iron coming in contact wtih it. The effect practically will be the same whether the core is green sand, or dry sand or whether it is coated or uncoated. Iron of a composition that will show a chill when it comes into contact with a sand core, will show practically the same depth of chill if poured in an open sand mold. One possible solution of the present trouble is to employ a lighter chilling mixture and heavier chill rings on the wheels which must show a heavier chill than usual on the treads. The natural objection to this of course is the expense of maintaining two sets of chill rings for one size of wheel, one set for the wheels requiring a normal depth of chill and the second for wheels in which the chill must be deeper. The center cores in these wheels probably are made in one piece with the core that forms the oil chamber. In that case it is no use suggesting the advisability of omitting the hub core altogether. The hubs of many small wheels and other castings are cast solid and the center hole is bored afterward through clean, solid metal. One possible solution for the problem would be to grind the center hole instead of finishing it with a steel tool in the ordinary manner either in a lathe or under a drill. Grinding devices for this purpose are available and may be secured, also expert advice on the subject, from grinding machine manufacturers advertising in THE FOUNDRY.

MALLEABLE

Carbon Is Too High

We are in a quandary due to the variations we are obtaining in physical tests since one of our contracts calls for 15 per cent elongation in 2 inches, and a tensile strength of 50,000 pounds per square inch. We submit three bars and two must measure up to the specifications, but we only average 12 to 13 per cent as may be seen from the following figures: Tensile strength, 54,000 pounds per square inch, elongation 13 per cent; tensile strength, 51,000 pounds per square inch, elongation, 12 per cent, and tensile strength, 52,300 pounds per square inch, elongation, 12.5 per cent. A fair average analysis of our white iron is as follows: Silicon, 0.80 to 1.0 per cent; sulphur, 0.05 per cent; phosphorus, 0.168 per cent; manganese, 0.29 per cent, and carbon, 2.50 to 2.65 per cent. Our annealing is run to 1750 degrees Fahr. in the usual cycle.

It is doubtful whether an elongation of 15 per cent in 2 inches can be maintained continuously with a total carbon range of 2.50 to 2.65 per cent, although it may be reached part of the time. To attain the desired elongation it is suggested that you reduce your total carbon, say to 2.35 per cent or so.

Problems in Nonferrous Founding

By Charles Vickers

Air Is Entrapped

We are manufacturing tire molds in which we use aluminum matrixes. There are two sizes varying in weight from 55 to about 225 pounds, and the castings have to be as dense as possible to prevent imperfections on the tire surface. To attain the desired density we employ a chill which is heated before use. A good working surface is obtained where the chill is employed, but the upper or cope surface of the casting contains blowholes which we attribute to trapped air or gas, or foreign impurities. We have tried various means to overcome the difficulty without success.

The molding is ring-shaped and it is gated from a central sprue with runners straight across connecting opposite sides of the cavity. That arrangement confines the blowholes on the cope side in small areas where the gates enter. We have tried numerous gates, but it appears that the fewer the gates, the better the confinement of the holes to definite areas. The aluminum used is remelted ingot, higher in copper than No. 12. The metal is melted in an iron pot, and is dipped out into ladles for pouring. Pyrometers are used in melting and pouring. The temperatures employed are 1275 to 1300 degrees Fahr. in melting, and 1225 to 1260 degrees for pouring. We wonder whether the handling during melting may be a factor in creating the holes.

From the evidence presented, it appears that the metal being used is aerated at some point between the furnace and its settlement in the mold. Molten aluminum is viscid like certain oils, and any air mixed with it does not escape easily. There is a tendency of entrapping air in the molten metal in the practice you employ, if it is done carelessly. The metal should not be allowed to fall any great distance. The shorter the fall, the less the tendency for air to be entrapped. That applies both to the pouring from the furnace and into the mold. You can try that out for yourself. Try pouring into a ladle from a height of 18 inches and examine the castings. The same thing can be done with a mold. Then pour the metal so that the distance between the two is at the minimum. You will find that where the distance is least, the better the castings as far as blowholes are concerned. Information on that subject is contained in "Pouring Height Should Be Low in Casting Aluminum Alloys," by D. B. Hobbs which appeared in the Sept. 1, 1929 issue of THE FOUNDRY.

Q & A

High Heat Needed

We would like some information on the subject of making monel metal castings. Are the molds cast in green sand or are they dried, and how should a mixture of around 64 per cent nickel, 36 per cent copper, with a small piece of aluminum added be melted and poured?

Monel metal, because it has a base of nickel, has a high melting point, around 2480 degrees Fahr., and its pouring temperature is variously given at from 2730 to 3000 degrees Fahr. An oil- or gas-fired crucible furnace will melt and bring this metal to its casting temperature. Therefore, if the melting equipment does not include a high temperature furnace, it will be best not to attempt to make monel metal castings.

The high pouring temperature of monel metal renders ordinary brass molding sand unsuitable for the molds, as it is not intended to withstand such a temperature. When only a few heats of monel are to be cast, a facing of new molding sand 10 parts; fine grained silica sand 5 parts, and one part of ground clay, should be well mixed and sieved, and wetted to proper dampness with molasses water. It should be prepared the previous night, banked, wetted, and allowed to mature until morning. This should be used as a facing on all parts of the molds which are exposed to the liquid metal. The backing sand should be heap sand, not finer than a No. 1 grade.

One foundryman prefers to use a facing composed of 1 part Jersey fire sand to 2 parts No. 2 grade molding sand, wetted with a solution of 30 parts water to 1 molasses, but of the two facings the first mentioned is best. It is advisable to skin dry the molds thoroughly and pour them before they get cold. They can also be put into the oven overnight as convenience dictates. We do not advise the addition of aluminum as a deoxidizer, it is better to use silicon-copper, adding 1 per cent of the 10 per cent alloy. Either plumbago or silica flour mixed to a cream with molasses water is used for coating the molds. If you have many castings to make, use the following sand mixture for light castings: 1 part No. 1 Albany, 1 part Jersey, and 3 parts old black sand. Mix with water or clay water until the sand is moist enough to stick together when squeezed. Medium castings may be made in a mixture consisting of 2 parts of old black sand, and 1 part new Albany No. 1.

Q & A

Gating Causes Trouble

We are making some small brass castings for a water softener which have to withstand 100 pounds per square inch water pressure. The castings are tight at all places except at the gate where the metal is poured in. This portion sweats water under pressure. The alloy we use contains 87 per cent copper; 3 per cent tin; 2 per cent zinc, and 8 per cent lead.

It appears to us as though your difficulty is caused by faulty gating since the castings are tight except at the gate. It may be that the gate is too small for the casting and instead of feeding metal, draws it away as it solidifies first. Perhaps the branch gate leading from the sprue to the casting is too small and freezes before the casing or the sprue are solid. This prevents any feeding of the casting. Therefore, we suggest that you try changing your method of gating and see what difference that makes.

If you want to try other alloys, the following are admirable for pressure castings: Copper, 82 per cent; tin 7.5 per cent; zinc, 4.75 per cent; lead, 5.75 per cent; aluminum, antimony and iron, none. Another alloy containing nickel is as follows: Copper, 89 per cent; tin, 6.5 per cent; zinc, 2 per cent; lead, 1.5 per cent, and nickel, 1 per cent.

BILL

By Pat Dwyer

Talks About Clams and Core Sand

SOME TIMES," Bill remarked the other night as we sat in front of the fire, "some times I wonder if we have not the wrong slant on this here now business of living."

"Maybe yes," I admitted cautiously, "Maybe no. Up to the present I have learned of only two alternatives. You live or you do not live. Am I to infer from the lengthy and no doubt carefully thought out opinion which you just have delivered in a straight forward, manly manner, that you are in favor of the deepest depression. You sonally, I am in favor of sticking around for another decade or two, if for no other reason than to see how periods of prosperity inevitably follow periods of the deepest depression. You and I have seen several of these slumps since we started to earn a more or less honest living in the sweat of our brow. We have weathered them all have we not? We have looked vainly for jobs and we have worked short time, but on the other hand, if you want to argue about it, we have had employers bidding for our services. We have worked over time and Sundays and we have seen the scale of wages approximately trebled and the working week reduced from 60 hours to 44 hours."

"That is just the trouble," Bill said, "that sweat of the brow stuff. The wages have gone up and the hours have come down, but you can't get away from the fact that we still are chained to a job. I should not mind if every one was in the same boat, but when I look around and see birds who never did a tap of useful work in their lives, and who apparently lead a happier life than me—or should I say I? —I sometimes wonder if I have the right idea, or, if I simply am a goat.

"Mind you I am not referring to these lads whose fathers carefully greased the skids and shot them—the kids, not the skids—beyond the necessity of earning a penny. They have a fairly legitimate excuse for living like so many butterflies.

"The birds I have in mind—and birds is right—they live like the birds of the air—the birds I have in mind, never earned a penny and never inherited one, yet they eat and sleep, spend their time to suit themselves and take orders from no living man."

"Who are these favored individuals?" I naturally inquired, "Do you know how they do it and—what perhaps is more important—what steps are necessary to join the organization—if they may be organized?"

What's a Million or Two Among Friends?

"Unfortunately," Bill replied, "I cannot answer the second and third questions. I have puzzled over the problem for many years, but up to the present the happy solution has escaped me. I may get it yet. In the meantime I have to keep plugging away at the daily grind and in my spare time envying those fortunate individuals who have discovered the secret of living without effort.

"I met three of them last summer while on a vacation down East. We went out in a boat—"

"You told me about that before," I reminded him, "about how you and three other lads went out swordfishing. You will pardon me if I gathered a mistaken impression from your account, but it seems to me these three lads performed yeoman service that day. Harpooning a swordfish and dragging the 10-foot body aboard is not exactly child play. These men were not loafers—"

"You're blame tootin' these lads were not loafers," Bill interrupted enthusiastically, "However, I was not referring to them. These three lads I am talking about now were in a different category altogether. They were lively enough and all that kind of thing. In face, if anything, they were too lively, but their efforts were devoted to sport and not to work, if we accept the term work in the ordinarily understood sense. That is, effort exchanged for gain, either in the form of filthy lucre or for some negotiable commodity. I forget now, who suggested the thing first. Probably Archie. Very ingenious lad, Archie. Always thinking up new ways of killing time. Anyway some time in the afternoon while the four of us played forty-five for almost unbelievable sums, the suggestion was advanced that we should go on a clamming expedition the following day. At first I was inclined to inquire on what basis the expedition was to be financed, but after noting how cheerfully the players wagered, won and lost vast imaginary sums all afternoon, I decided that money was a detail of no importance, one that would take care of itself. After events fully justified this belief. A brief examination of the beach and a short mental calculation showed that the tide would be at the lowest point of the ebb about 4 p. m. That meant we could commence excavating on the clam beach about 2 p. m. and could follow the retreating tide for a couple of hours. At any stage beyond half high water the beach is submerged."

"I have dug clams," I said, "therefore you may omit the natural history lesson on the influence of the moon on the tides and how they rise and fall twice every 24-hour day. A slack period at the peak of the flow and another similar period at the end of the ebb, adds about an hour to the cycle. For that reason, high or low water is about an hour later each day at any given place. Let the sailors worry about that. Carry on with the clams."

"Since you are such a smart little fellow," Bill remarked, "I need not tell you that we planned to leave our side of the harbor about 1:00 p. m. That would give us an hour for the passage in the event we had to beat up against a head wind or on the other hand if we had to crawl along slowly under a favorable but light breeze.

"The other two eventualities—get that, eventualities—a dead calm, or a whistling gale from the north were

dismissed carelessly as those kind of bridges you do not cross until you come to them.

"Archie favored a motor boat for the trip, but Tommy bitterly pointed out that every one either was in use or the cabin and engine room were locked up as tight as their owners.

From Celebrated Nautical Painting; Dropping the Pilot

" 'The suspicious nature of some of these lads,' he complained, 'is positively beyond belief. Actually gives the place a bad name. Here's Bill now f'rinstance, a visitor in our midst as you might say and we are prevented by these crabs from showing him proper hospitality. There should be a law or something—'

"He was interrupted by Jim who said he knew where a sail boat was moored. The owner was out of town temporarily and the boat was just lying there idle, or as Jim expressed it in a slightly mixed metaphor 'Lying there like a dog in the manger, eating it's head off!'

"We met at the appointed place on the following day and I was humiliated to discover that I was the only one who was not properly equipped for the expedition. Archie, Tom and Jim wore long rubber boots. A moment's reflection indicated that perhaps the rubber boots were justified, but I could not imagine why Archie carried a double barrel shot gun, why Tommy displayed a heavy revolver and Jim had a long, wicked looking knife in a sheath at his belt."

"Wait a minute," I exclaimed in astonishment, "I thought this was a claim digging adventure? I know the claim is a wily animal with a disconcerting and disgusting habit of squirting half a pint of water in your eye when you reach after him in his nest, but I never have heard of any person attacking him with fire arms or long knives. Don't tell me the game laws have changed to the extent that you first have to flush him and then take him on the wing. You will be telling me next, that one of the gang had a couple of clam hounds in tow!"

"Well," said Bill, "I'll tell you. The same line of thought flashed through my mind and I glanced around surreptitiously to see what type of dog had been developed for this line of sport. Unconsciously I conjured up a vision of a long, slinky animal, built to the general specifications of a daschund, you know, long wheel base, low hung chassis, and so forth, also a sharp snout and long curved claws for coaxing the clams out of their hidie holes. However, I saw no animal of this or any other kind in the vicinity. As a guest I did not want to appear unduly inquisitive. We climbed aboard and pushed off with a nice quartering breeze filling the main sail and jib. About half way across the harbor the distressing discovery was made that no one had brought any bait. I wondered. We had started out presumably to dig clams. The sight of the fire arms had suggested that the intention was to shoot them and now apparently the plan was to catch them with a hook and line.

"A timid inquiry on my part was met by a general laugh. The bait was for the use and benefit of the fishermen and simply was a facetius colloqualism for liquid refreshment.

"Archie—ever resourceful Archie—pointed to a schooner lately in from St. Pierre, and modestly admitted that the skipper was a friend of his. " 'What Ho!' says he, 'What are friends for unless you, can use 'em? Stand by, my bully boys, to go about!' Beating back to the schooner, hobnobbing with the captain and crew and one thing or another consumed another precious hour, but as Tommy sapiently pointed out, clams are not migratory animals. They were there yesterday, they are there today and without peradventure of doubt, would be there tomorrow. On the other hand, the opportunity of securing —free— a quart bottle of strong water that never contributed a cent to the revenues of his imperial majesty king George V—God save him—did not turn up every day.

"This patriotic sentiment suggested a toast to the king and was duly honored. He will be glad to hear that!

"In deference to our late benefactor, Archie graciously proposed 'St. Pierre. May she never run dry!'

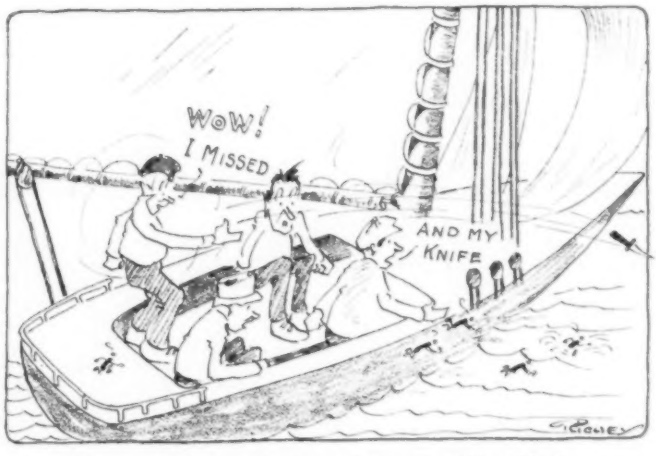
"The close co-operation and unanimity of action usual on occasions of this kind was slightly marred by the absence of glasses. The bottle was passed from hand to hand, but strictly according to the rules of etiquet and the laws of sanitation. Each lad rubbed the palm of his hand across the mouth of the bottle before he applied it to his lips. The same pitiful and betraying gesture is not uncommon among diners who polish the silver with their napkins before they commence to eat.

"As a prelude to *The Ladies* and also singularly apropos of the object of the expedition, Jim sang with great feeling the tender and sentimental ballad of Mary Ann McCarthy, the lady who never got a —er—Ah—that is I mean to say—the lady who failed so emphatically to get any clams. This was a particularly happy inspiration because naturally it called for further libation to better luck on our part.

"When the bottle was empty it was thrown overboard and so long as it remained in range we amused ourselves by shooting at it with Tommy's revolver. Shooting *at* it is right because, for some reason, all the shots went wild.

"Then Jim declared that if it wasn't for losing an heirloom in the family, he could have split the bottle with his knife. To prove his skill with this formidable weapon, he launched it at the mast and drove the point over an inch in the wood.

"Tommy criticised Jim's under hand method. He claimed that the proper technique of knife throwing lay in first concealing the knife point up between the shoulder blades. When the time came for action, a single lightning like over arm swing snatched it from its place of concealment and sent it whizzing to its destination. 'Look' says he, 'Just like this.'



Very Hard To Hit One of These Shifty Masts

"So far as speed was concerned, his theory was O. K., but unfortunately—as he explained afterward—he saw two masts instead of one. He cut his

ear. The knife flew past the mast, through the jib and disappeared in water that at this point was reputed to be 10 fathoms deep. Jim made a vicious pass at Tommy and that gent certainly would have gone to the bottom after the knife if I had not grabbed him by the leg and pulled him aboard.

"Archie added the finishing touch, just before we landed. Tommy was in the bow, ready to jump. I had the tiller. Archie and Jim were seated side by side on the center thwart, Archie facing aft and Jim facing forward. The butt of the gun rested on the thwart between Archie's legs and the muzzle was pointed to the sky. Without a word of warning he fired both barrels. He claimed afterward, he did it partly for a joke and partly to take Jim's mind off the loss of his knife. Boy! He certainly succeeded beyond his most sanguine expectation.

"The heavy charge of shot cut the peak and throat halliards and everything came down by the run. The block fell on Jim's head and laid him out stiff. The sail buried Archie and Tommy jumped overboard. Fortunately we were in shoal water close to the beach and the boat had enough way on her to bring her in."

He Gets an Inquiry

"Well" I said, "did you get any clams?"

"Clams?" Bill echoed, derisively, "By the time all the arguments were settled amicably, the block replaced and the halliards spliced, the rising tide had covered the beach and the clams were as safe as Jim's knife.

"Talking about clams and beaches and that kind of thing" Bill continued "reminds me of an inquiry I had from a foundryman the other day. He said that he had charge of the core room in a gray iron foundry where many of the castings were molded in dry sand cores. Instead of the usual pattern, flask and sand, two or more cores were fastened together to form the mold. Properly speaking these blocks of sand are not cores, since they are designed to form the outside and not the inside of the casting, but since foundrymen have fallen into the habit of calling every lump of sand that goes through an oven a *core*, we'll let that point go for the moment.

"He set forth his inquiry under five heads, as the lawyers say, to wit, as follows: 1—What kind of a sand mixture can be used and reclaimed. 2—What is the proper proportion of binder, new and reclaimed sand. 3—Is the same mixture employed irrespective of whether the sand is dried with a torch, skin dried over a fire, or dried in an oven. 4—What is the proper size of coke to use under a mold in the floor, what is the proper depth for the bed and are empty facing sacks the best medium for covering the coke in the bed. 5—What kind of core binder resists the highest heat, that is to the best advantage.

"These questions cover such a wide range and seemed to indicate such a thirst for information, that I suggested he should secure one or maybe several books which are available and which cover the subject of molding and coremaking. For his convenience I enclosed a list of these books with the titles, authors, publishers, prices and brief synopsis of the contents. A letter is sufficient in some instances to answer specific questions, but there is nothing like a good, reliable book from which a man can take his own information in small or large doses, depending on circumstances.

Take Them in Order

"I wrote him that I would take his questions in the order in which they were presented, and would answer them briefly. From these answers he readily could see that the subject was too great to cover properly in an ordinary letter.

1—Practically any kind of sand may be reclaimed and used over again if the foundryman has the necessary equipment and is thoroughly familiar with the properties and characteristics of sand and the application of binders. Lacking this knowledge, or delegating the work to some person who is not properly qualified, will lead to nothing but loss and disappointment. Sand reclamation, particularly on any extensive scale, is work for an expert.

2—The proper proportion of new and old sand and binder varies according to the shape, size and position of the core in the casting. Physical characteristics of the sand also must be taken into consideration. For example, intricate cores on the inside of a casting must be made from a clear, sharp sand. Covering cores and others of a like character may be made from old, burned sand or heap sand bonded with any material that will hold the grains together. Other cores, depending on position, amount of handling required and many other factors, are made satisfactorily from mixtures that range between these two extremes. There is no such thing as a standardized mixture suitable for all occasions.

3—This is a seemingly contradictory question since in perfect good faith it may be answered by either a yes or no. The same sand mixture *may* be employed irrespective of whether the face of the mold or core is dried with a torch, an open fire or in an oven. However, if the sand has to occupy a position where it is not properly supported, manifestly a sharp sand without any natural binder cannot be employed. This form of core mixture would serve admirably in a flat core turned out on a plate and could be dried with a torch, an open fire or in an oven. The mixture could not be used, in a high wall. It would collapse in the green state. The method employed for drying a core or mold is immaterial, so long as the object is accomplished.

4—The proper size of coke to use under a mold is any size larger than coke breeze. In other words the coke from the stock pile. The usual depth of a coke bed is 4 to 6 inches. In modern American foundry practice, the coke bed is not covered with bags of any kind, neither is it covered with wrapping paper, hay or straw. The habit went out with the bustle, the horse and buggy, grading by fracture and other quaint peculiarities of yester year.

The coke is pounded down firmly with the butt end of a rammer and then covered immediately with the first layer of sand. The purpose of the coke is to allow the gas and steam to escape freely from the sand close to the molten metal. Therefore why should the passage be hindered by a layer of old bags, paper or straw?

5—This is another equivocal question. If he means which requires the highest heat in the oven, the answer is that sand in which linseed oil is employed as a binder, requires the highest temperature to function properly. If the question is designed to find which core mixture best resists the heat of the molten metal, the answer is that the binder is not a factor of any importance. The refractoriness of the sand determines this point.

Book Review

Metallurgy of Bronze, by H. C. Dews, cloth, 147 pages, 5½ x 8⅜ inches, published by Isaac Pitman & Sons, New York, and supplied by The Foundry, Cleveland, for $3.75 with postage 15 cents extra, and in London by the Penton Publishing Co. Ltd., 416-17 Caxton House, Westminster, for 17s 6d, postage extra.

While considerable material has been published on the metallurgy of bronze, it usually is difficult for those interested in the subject, to place their hands on the literature relating to a definite point without waste of considerable time and effort. Therefore, foundrymen, foundry metallurgists, and others who from time to time must refer to the subject of the metallurgy of bronze will welcome this new volume which brings together in accessible form, much material that previously was scattered widely. The author is a prominent British metallurgist whose research work has clarified many points in bronze technology. The book is divided into 12 chapters with two appendixes. Chapter I relates to the copper-tin equilibrium diagram, and Chapter II describes the cast structure of bronzes. Properties of bronzes in general is the topic of Chapter III while Chapters IV and V cover phosphor bronzes and zinc bronzes respectively. The effects of lead, nickel, minor constituents and gases on bronze are dealt with in Chapters VI, VII VIII and IX respectively which

contain much valuable information.

For many years the author has pointed out that many of the defects in bronze castings which were attributed to various factors, actually were due to incorrect pouring temperatures, and in Chapter X he covers the effects of casting temperature in detail. Chapter XI gives some pointers on melting, and Chapter XII is devoted to segregation and liquation. Appendix I gives a rather sketchy outline of the microexamination of bronze while Appendix II consists of a table giving the physical constant of the constituents of bronze.

Reader's Comment

EDITOR'S NOTE—*Material Appearing Under This Head Does Not Necessarily Reflect the Opinion of* THE FOUNDRY *or of Its Editors.*

Hardened Gray Iron Is Used

TO THE EDITORS:

We have read with much interest "Hardening Gray Iron May Have Industrial Applications," by A. F. Shore which appeared in the Dec. 15, 1930 issue of THE FOUNDRY, and believe that it would be of interest to point out that in England, hardened cast iron is finding a considerable number of applications on a commercial scale, particularly in the automobile industry.

Renewable cylinder liners are perhaps the most outstanding application as they have been in use in large quantities for about two years. The liners which are made almost invariably from centrifugal castings, are pressed into the bored cylinder block. These furnish a means not only of making the cylinder bore of an exceedingly hard material to reduce wear, but also supply a ready means of bringing back the cylinder bore to standard dimensions without having recourse to oversize pistons and rings when wear ultimately does take place.

As the liners usually are only about 3/32-inch thick, it may be observed that considerable care has to be taken in avoiding distortion during heat treatment. The firm with which I am associated has a patented method for forcing the heated liner into a die at the same time it enters the quenching oil, thus insuring that the finished liner is within a few thousandths of an inch of being perfectly round.

A tempering operation subsequently is given, and after grinding on the outside and pressing into the cylinder block, the bore is finished to standard size by internal grinding or honing. Hardened valve seats also made from centrifugal castings are being used to quite a large extent, and hardened valve guides have in many cases been adopted to overcome the seizing of the comparatively soft, present-day valve stems as is the case with ordinary cast iron untreated and soft gray.

In the heat treatment of cast iron it is necessary that the chemical composition and also the heat treatment temperatures should be under the closest possible control if consistent results are to be obtained. Hardness limits as determined by the Rockwell tester, for hardened cylinder liners are 40 to 50 on the C-scale which roughly is equivalent to twice the brinell hardness number of a good quality gray iron.

T. R. TWIGGER

Technical Department,
British Piston Ring Co. Ltd.,
Coventry, England.

What's the Trouble

TO THE EDITORS:

A query frequently heard among foundrymen, singly and in groups is: "Where are our future foundrymen?" The reason for this query is given in the plaintive statement: "No young fellow seems to care about studying the foundry business. It is too hard and too dirty."

My experience seems to indicate that the fault lies with the foundrymen and not with the young men. At the age of 18 I decided to learn the foundry business and make it my life work. I served an apprenticeship of four years and also completed a correspondence course in mixing irons and cupola practice. At the close of my apprenticeship I enrolled in a prominent school in a large eastern city and completed a course in foundry management and operation. I was graduated in June 1929 and shortly thereafter secured a position as assistant to a foundry superintendent. After 8 months service I was let out and have not been able to secure a position since.

I have written 80 letters to foundries from Maine to California. I have answered all kinds of advertisements. I have called at dozens of plants in the past year and did not receive the slightest encouragement. Can you tell me what is the trouble?

I am not looking for an important position. All I want is to get into some good organization where I can make some progress. I am willing to do my share and am not afraid of hard or dirty work. I like the foundry and will work for enough to live on so long as I am learning a business which I want to make my life business.

The whole situation seems queer to me and every time I hear old timers talk about the foundrymen of tomorrow and where they are coming from, I think it is nothing but a lot of bunk.

NEW ENGLAND

Speeds Shop Production

TO THE EDITORS:

One steel foundry has found a valuable aid in checking defective castings. It consists in the proper functioning of a shop committee. That committee is made up of the following men: Assistant molding foreman, mold inspector, cleaning room foreman, and pattern shop checker.

The committee meets promptly at 8 a.m. in the cleaning room to inspect castings made the day before, and particularly to go over castings at the welding department. The pattern shop checker acts as secretary and makes notes of defective, etc. This meeting is short and snappy, never lasting over 30 minutes. Nothing ever is allowed to *die* at the welding department. The casting is either welded at once or scrapped. That one point tends to speed up delivery more than any one thing.

The committee again meets promptly at 4 p.m. at the pattern lay out bench where new patterns for the next day's work are placed. Methods of gating and heading are decided on at that time, notes being taken as before.

This shop committee idea is nothing new but it is doubtful if it is followed constantly in many shops. It is well worth a trial.

S. R. ROBINSON

Springfield, O.

Regional Meeting Held

A regional meeting on industrial education was held in the Public Service auditorium, 80 Park Place, Newark, N. J., Feb. 14. Addresses were made by Dr. Harry Myers, consulting industrial engineer, Dayton, O.; A. D. Lynch, personnel manager, and L. W. Olson, factory manager, Ohio Brass Co., Mansfield, O. The meeting was held under the auspices of the National Founders and the New Jersey Foundrymen's associations.

Appointed Manager

Sullivan Machinery Co., 400 North Michigan avenue, Chicago, has appointed Chester G. Cummings manager of its Cleveland office to succeed R. T. Stone, resigned. Mr. Cummings has been associated with the New York office of the company with headquarters at Syracuse, N. Y.

Experiments With Chromium In Gray Iron

By T. F. Jennings

MANY interesting articles describing the effects of chromium in cast iron mixtures in recent years have merited the attention of practical foundrymen. A study of these articles indicates that an enormous amount of work has been involved in this investigation. Results reported by investigators in various sections of this country, also by those in foreign countries, are remarkably consistent, considering such varying factors as, method and speed of melting, quality and type of charge, sand conditions, etc. Any or all of these factors unquestionably influence the results.

While this article refers only to the effects of chromium, others have recorded the effects of chromium and nickel in various proportions. The ratio of these two elements should be approximately 2 parts nickel to 1 part chromium to effect a marked improvement in the strength of gray iron castings. The silicon content and thickness of section of course must be taken into consideration. Considerable improvement in the strength of gray iron can be effected by the addition of either chromium or nickel. Briefly summarized, chromium increases the hardness, strength and wear resisting properties of gray iron.

In ordinary foundry practice, chromium is added to the charge in the form of ferrochrome, an alloy of chromium, iron, and carbon and a product of the electric furnace. This alloy contains from 60 to 70 per cent chromium, 4.00 to 7.00 per cent carbon and the remainder, iron. It is a heavy, dense alloy with a silvery fracture, usually is irridescent on the surface and melts in molten iron without a great deal of difficulty.

Gathers the Facts

WHAT properties in gray cast iron are affected by the addition of chromium in the mixture? In answering this question, the author has made a study of the various articles which have been prepared on the subject, using that material to check his own research work. The article which explains the influence of various percentages of chromium on machinability, hardness, strength, resistance to oxidation, fluidity, and shrinkage is abstracted from a paper presented at the Cleveland convention of the American Foundrymen's association. The author is superintendent of foundries, Utah Copper Co., Garfield, Utah.

Even with small additions of chromium, changed structures of the iron are revealed by microscopical examination. The most perceptible change is in the size of the graphite flakes. Formation of large flakes always is retarded. Depending on the analysis of the iron, as little as 0.25 per cent chromium sometimes is sufficient to render the iron pearlitic. This is particularly important in present day practice where the trend in all recently improved processes is toward a eutectoidal cast iron. Chromium when added to molten iron combines chemically with carbon and iron thus diminishing the amount of carbon which otherwise would separate as graphite flakes during solidification and which tend to soften the iron and promote an open grain structure. Graphite appearing under the microscope not only is decreased in amount but also is decreased in size. Chromium has more than a hardening effect. Indirectly it closes the grain as well.

Formation of chrome iron carbides at the expense of the graphite occurs with small additions of chromium and gradually increases until little free graphite is found where the chromium content is up to 3.00 per cent. Table I, by Piwowarsky, clearly shows this effect of chromium in reducing the amount of graphitic carbon regardless of the silicon content.

Table I

Reduces Carbon Content

Silicon Per cent	Chromium Per cent	Graphitic carbon Per cent	Combined carbon Per cent
1.11	0.00	3.06	0.71
1.06	0.15	2.98	0.63
1.01	0.30	2.97	0.83
1.03	0.51	2.76	0.97
1.82	0.00	3.26	0.44
1.80	0.14	3.23	0.52
1.81	0.28	3.05	0.65
1.68	0.48	2.80	0.80
2.76	0.00	3.45	0.26
2.71	0.14	3.42	0.32
2.74	0.29	3.41	0.33
2.77	0.53	3.20	0.57

Table II

Affects Hardness and Strength

Analysis						Transverse strength	Deflection in inches	Brinell
Carbon	Chromium	Silicon	Manganese	Sulphur	Phosphorus			
3.74	0.08	2.18	0.53	0.074	.460	1892	0.186	156
3.60	0.20	2.35	0.62	0.063	.474	2056	0.216	183
3.84	0.35	2.20	0.53	0.057	.374	2515	0.233	196
3.92	0.48	2.29	0.48	0.062	.288	2498	0.225	212
3.69	0.69	2.02	0.50	0.048	.364	1635	0.148	183
3.84	0.81	2.34	0.56	0.057	.266	1952	0.266	187

Table III

Alloy Reduces Fluidity

Test	Chromium	½-inch section	¼-inch section	⅛-inch section
A	0.00	full	full	full
B	0.37	full	full	75 per cent
C	1.68	full	full	25 per cent

These chemical analyses not only show the decrease in graphitic carbon with each small addition of chromium but also show the corresponding increase in combined carbon. This is a point not to be overlooked, as the physical characteristics of the iron, hardness, strength, chilling tendency, and resistance to abrasion depend, to a great extent, on the amount of combined carbon present. A gradual improvement in strength accompanies the increase in combined carbon only to the point of eutectic composition or about 0.80 per cent of combined carbon. Further additions of chromium convert more of the graphitic carbon to free cementite, the hardening constituent in iron, which accounts for the increase in hardness without corresponding increases in strength beyond certain points.

Experiments Conducted

Investigations have shown that certain limits exist on the quantity on chromium that may be added to cast iron if machinability is to be retained in a given thickness of section. These limits are raised with an increase in the thickness. Some time ago the writer conducted a series of experiments in which cast iron scrap was melted in an ordinary crucible with gradually increasing amounts of ferrochrome. Each heat was poured into 1-inch diameter test bars.

With iron containing carbon 2.86 per cent, silicon 2.72 per cent, manganese, 0.50 per cent, sulphur 0.062 per cent, phosphorus 0.794 per cent the maximum permissible addition of chromium before variation in ease of machinability occurred was between 0.52 and 0.63 per cent.

Another investigator employed an iron analyzing carbon 3.16 per cent, silicon 1.48 per cent, manganese 0.97 per cent, sulphur 0.054 per cent, phosphorus 0.70 per cent and found that 0.40 per cent was the upper limit for chromium content. However his results probably were influenced by the higher manganese content in the original iron.

These results may be open to criticism because the iron was melted in a crucible rather than in a cupola and might not be considered a fair representation of what might be expected under different conditions. However, no special precautions were taken to refine the iron, before casting. Consequently it is just as logical to assume that more chromium might be added in regular foundry practice where every factor affecting quality has been controlled carefully before proceeding.

Transverse strength and deflection usually are augmented by additions of chromium up to about 0.50 per cent due in part to the refining action of the chromium in preventing separation of large graphite flakes. Where chromium additions between 0.50 per cent and 1.00 per cent are desirable and simultaneously high strength iron is necessary, addition of nickel is suggested to restrain the effect of the excess cementite formed. This practice is not uncommon among foundrymen who have given these conditions some thought.

A series of chromium bearing cast irons made some years ago at one of the leading universities and where the iron was melted in a cupola confirms the foregoing. The results are shown in Table II. The bars were broken on 18-inch centers.

Hardness as shown by brinell numbers was included in this summary to dissipate in a way, a prevalent idea among foundrymen that an addition of more than 0.50 per cent chromium alone is objectionable from the view point of machinability.

With a lower silicon content and extremely light sections, this is true, but where the lightest section is 1-inch or more, hardness as might be expected, is not in proportion to the amount of chromium added. Recently the author examined a block of cast iron 5 inches thick that contained only 0.40 per cent silicon and 1.68 per cent chromium. It had been drilled with a 7/16-inch bit to demonstrate that although a little difficult, still it was machineable.

Table IV

Typical Mixtures

No. 1, Pounds

3750	Steel scrap
1250	Soft iron scrap
150	Ferrochrome
800	Coke
150	Limestone
20	Purite

No. 2, Pounds

4000	Returned scrap
1000	Soft iron scrap
100	Ferrochrome
800	Coke
150	Limestone
20	Purite

Castings Resist Oxidation

Resistance to atmospheric corrosion or oxidation is improved slightly by small additions of chromium, but for a marked improvement more than 1.00 per cent should be added.

Small additions of chromium are advantageous if the castings are to be exposed to high temperatures. The strength at elevated temperatures is improved definitely even with less than 0.40 per cent chromium. Such small additions prevent softening after prolonged exposure at 1700 degrees Fahr. Higher percentages reduce materially the loss due to oxidation In addition to these properties it has been shown that chromium definitely retards castings growth when repeatedly heated and cooled, thus materially improving iron castings used where stresses of this nature are encountered. The author plans to conduct tests, in the use of chromium as an alloying agent in heavy chill blocks, that after repeated use usually become fire-checked thereby reducing the life.

As the amount of chromium is increased beyond an addition of 1.00 per cent, the hardness is increased rapidly. Only at rare intervals are alloyed irons found containing between 1.00 per cent and 3.00 per cent chromium unless the casting has been designed to resist abrasion in some form or other.

To measure the effect of chromium on volume shrinkage, we decided to cast relatively heavy blocks (5 x 5 x 25 inches) in sand and weigh them after cooling, assuming that such a procedure would at least indicate the size of the pipe cavity caused by the natural shrinkage of the metal. The results follow:

Sample	Chromium Per cent	Weight Pounds
A	0.00	78.5
B	0.37	78.0
C	1.68	80.0

From these results it appears that chromium alloyed irons certainly do not effect the final shrinkage seriously. No way of measuring specific gravity was available, but it is reasonable to assume that an iron which contains chromium iron carbides instead of graphite must be heavier per unit size.

Fluidity Is Tested

In attempting to measure fluidity, we decided to pour several flat castings ½-inch thick about 10 inches square and reduced in 1½-inch steps to ¼-inch and ⅛-inches respectively at one end. These were poured with the steps on the cope side and opposite the gate. The results appear in Table III.

This home made method of determining the fludity, while perhaps unscientific, indicates just what we all want to know: Can such thin sections as are met in the foundry be poured successfully? The answer is shown in this table. The metal must be hotter than ordinary soft iron as chromium exerts a deadening effect.

Iron containing more than 1 per cent chromium finds it greatest use in abrasion resistance work which is a problem common in grinding, conveying and crushing machinery. When applied to these problems with a consideration of its low cost compared with more expensive alloys, its utility and possibilities are readily appreciated.

In view of the relative costs of pig iron and scrap steel, we find it advantageous to use high percentages of steel scrap. This practice was described by the author some years ago, in a paper presented before the American Foundrymens association and reproduced in THE FOUNDRY, Vol. LIV, page 779. Two mixes are used

both balanced in respect to chromium and silicon content, as shown in Table IV.

These charges, 10 to 12 each day, melt down with approximately a 20 per cent chromium loss. The iron is low in silicon resulting from the high steel portion of the charge, but we find this is an important factor in the quality of the metal. With more silicon the hardness would be lowered and if any change were considered at all, we would favor increasing the amount of ferrochrome.

Through the work of other authors and contributors to technical literature we find that chromium definitely improves cast iron, first with an increase in strength and hardness. Second, with higher additions, a rapid increase in hardness at the sacrifice of ductility.

The author is aware of the shortage of more exact data relative to the qualities imparted by this agent, but is firmly convinced that if given a thorough trial with technical supervision, its use will increase rapidly in the future.

High Temperature Metals Discussed

One of the features of the fifth Midwest Power Engineering conference and the fourth National Fuels meeting of the American Society of Mechanical Engineers, held at the Hotel Stevens, Chicago, Feb. 10-13, was the address of L. W. Spring, Crane Co., Chicago, on "High Temperature Metals for Power Plants."

In discussing high-temperature metals, Mr. Spring pointed out that superheating of steam has brought about a new interest in the testing of steels for steam power plants and oil refineries. Pressures up to 600 pounds per square inch are used generally, and several plants now are using 1400 pounds per square inch. New processes of oil refining also have had an influence on the steam plant. A recent inquiry for equipment named 1500 degrees Fahr. and 2500 pounds per square inch pressure as maximum for an experimental still.

Steam plant designers have determined to go ahead with temperature increases and already definitely have asked metallurgists and steel makers for materials to stand service for 10 to 20 years at temperatures up to 1000 degrees Fahr. Stronger metals than carbon steel, or at least a metal which loses less of its strength at higher temperatures, is needed because of the requirements for 3500 pounds per square inch pressures now being sought and to reduce the necessity for bulky valves and extraordinarily thick flanges. The effect of the temperatures upon materials was given as a factor more serious than the pressure problems. The *flow* or *creep* testing method was said to give results close to the actual truth regarding the pressures and temperatures which metals will stand in continued service. A question arises as to whether the engineer will want steel castings annealed completely enough to give the finest grain.

In addition to insufficient tensile strength for fibre stresses, and to take care of *creep*, the question of metal fatigue often is brought up, Mr. Spring stated. While fatigue of over-stressed metal is an extremely important factor at the lower temperatures, it becomes a much less serious factor as the temperature of operation rises. Apparently at temperatures of 750 degrees Fahr. or over, fatigue has lost most of its importance as a factor. Mr. Spring pointed out that austenitic steels show less loss of strength at the higher temperatures than do the pearlitic varieties. It was stated also that a question of chemical stability remains to be settled. Steels containing small amounts of nickel and chromium were reported to suffer much the same loss in strength at high temperatures as do the ordinary carbon steels. A nitrided alloy steel as valve seat metal gave satisfactory result in steam service. He declared the end is not in sight as to limits of pressure and temperature work.

Chicago Founders Hear Talk by Forbes

Technique in air furnace melting in the production of high-strength irons was discussed by Duncan P. Forbes, Gunite Corp., Rockford, Ill., in an address before the Chicago Foundrymen's club, Feb. 5, at the City club, Chicago.

Mr. Forbes illustrated the performances of the hand-fired, oil-fired and pulverized coal air furnace types, including variations from those general principles. He described his company's practice in producing iron ordinarily of 50,000 pounds per square inch tensile strength containing 2.80 per cent carbon and 2 per cent silicon using 60 per cent pig iron and 40 per cent remelt scrap. No scrap is purchased, it was stated, unless petroleum coke is used as a carburizer. In coal firing about 2½ tons of metal are obtained per ton of coal. A successful sand for molding of air furnace, high-strength iron was described as having the following characteristics: 80 permeability, 6 pounds green strength, and a high dry strength. Sand used is largely synthetic with some natural sand. Mr. Forbes emphasized the long duration of fluidity of the metal in the melting process. Molybdenum was among those alloys, from which successful results were obtained. By using that alloy, an iron of a tensile strength of 75,000 pounds per square inch and upward was achieved. One aim in high-strength iron production, Mr. Forbes said, was to secure a metal of high strength and practical machinability. Following his talk, Mr. Forbes answered various questions relating to comparative results of cupola and air furnace practice.

Book Review

N. E. M. A. Motor and Generator Standards, paper, 8 x 10½ inches, 132 pages, published by the National Electrical Manufacturers association, 420 Lexington avenue, New York, and supplied by THE FOUNDRY for $1.50 plus 15 cents postage and in London by the Penton Publishing Co. Ltd., 116-17 Caxton House, Westminster, for 7s. 6d., postage extra.

The book contains reference information on the application and selection, ratings, and performance. Comprehensive lists of definitions and abbreviations of terms pertaining to motors and generators are included. The previously mentioned material is applied to motors, generators, frequency converters and motors over 60 cycles for industrial purposes, large synchronous motor-generator sets, alternating current crane motors, alternating and direct current elevator motors, machine tool motors, and fan motors of the alternating and direct current types, polyphase induction and synchronous motors, etc.

Standard rated voltages, frequencies, speeds, horsepower or kilowatts and short-time ratings are given. Performance standards show efficiencies, power factor, temperature rise, and allowable variation from rated voltage and frequency. Motor standards include torque, speed changes due to temperature rise and overheating, and speed limitations of motors driving through belts and gears. Information on fractional horsepower motors includes standard maximum locked-rotor current and indicated starting current for generators.

Tabor Company Buys Titgen-Eastwood

The Tabor Mfg. Co., 6225 Tacony street, Philadelphia, has acquired the Titgen-Eastwood Co., also of Philadelphia, and now is manufacturing and selling the products previously supplied by the latter company. The Titgen-Eastwood company for several years has manufactured and sold a complete line of foundry equipment, including cupolas, sandblast equipment, furnaces, tumbling barrels, pressure blowers, dust collectors, core room accessories, etc., and in addition has supplied repair parts for the line of equipment formerly sold by the J. W. Paxson Co., Philadelphia. Since 1884, the Tabor company has manufactured a line of molding machines in various types and sizes. In addition to acquiring the patents and good will, the Tabor Mfg. Co. also has retained the entire personnel of the Titgen-Eastwood Co. F. R. Wallace is president of the Tabor Co.

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The Shakeout

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NORMAN F. HINDLE
Assistant Editor

¶ Pot Hunting Management

GOOD management finds two main channels through which to improve the business position and increase the income of any firm. These are economies in production, including the elimination of waste, and increased profit through better selling. Neither of these methods, proved and accepted by American business in general, follow the old precept of "cut wages to save money." Dr. Julius Klein, assistant secretary of commerce, speaking recently in Bridgeport, Conn., in relation to the depression which he states is passing, said,

> Don't fall into the fallacy so general among European industrialists of expecting the wage earner to bear the brunt of the readjustment. Before resorting to that extremity, let industry be sure that *every* other one has been exhausted. There is plenty of slack elsewhere—careless production, inefficient management, slipshod selling. Talk of drastic slashes in American living standards and "permanent lows" in wages borders closely on economic lunacy.

THE doctor is charitable in not ascribing this tendency to American industrialists and in ninety-nine cases out of a hundred, he is right. This depression fortunately has brought few examples of that type of mismanagement which holds that a wage and salary cut is the easiest way to hold up the profit curve. True, rumors have been rampant about "other fellows" who have cut their men, when they returned to work after being laid off. Most of these on being traced down are found to be exaggerated. Truly, the firm that would cut the pay of men, already reduced through part time employment, would class with the hunter who waits for the birds to settle before firing.

THE sentiment against needless wage cuts is not concerned with questions of labor policy nor is it an evidence of socialistic tendencies on the part of the majority of manufacturers. It merely is good business. Production schedules and sales quotas, during the better times ahead, will profit from the loyalty and cooperation that will follow unimpaired wage and salary scales.

¶ Cars Need Repairs

CLASS I railroads had 147,334 freight cars in need of repairs on Jan. 1, 1931, according to the service division of the American Railway association. That figure represents 6.6 per cent of the total number on the lines. Of that number, 110,229 were in need of heavy repairs. These figures are good news. Many branches of the foundry industry will be called upon to supply castings for repair parts. Side frames, bolsters, yokes and other castings from the steel division; brasses from the nonferrous; wheels and others from the gray iron and steel; and journal boxes and covers, bearing plates, stake pockets, etc., from the malleable division will be required. The foundry industry should be in a position to supply those needs at a price favorable to the railroads and assuring a reasonable profit to the castings manufacturer.

¶ At It Once Again

PRICE cutting is one of the greatest evils of the foundry industry. That statement has been made so many times that it would seem reasonable to think that every foundryman not only for his own good, but for the good of the industry would refrain from such practice. However, that is not the case. As soon as orders declined and work fell off, many foundries began to bid against each other for jobs. The result was that, with the price cutting going on within the industry, customers demanded lower and lower prices until castings are being sold at a price below cost.

THE argument easily may be brought forward that the price of pig iron, scrap and other materials has declined. That is true and a reduction in price of castings is allowable in relation to the decreased cost of those materials. However, some foundries are making castings at such a price that if it was possible to make the mold for nothing, the manufacturer still would be losing money. In one instance, a certain type casting which formerly sold for 10 cents per pound now is being purchased for 6 cents per pound, a reduction in price of 40 per cent.

THE only defendable selling price of castings is that which assures a reasonable profit. Until foundry operators, large and small, realize that fundamental truth, the price cutting evil will exist. When foundries present a united front on the price question and the only difference in selling price is represented by economies of operation, then and only then will the foundry industry advance.

Comings and Goings of Foundrymen

Men of the Industry, Whose Activities Are Making Foundry History

WADE M. BRISON, recently superintendent of the roll shop, International Nickel Co., Huntington, W. Va., and previously with the United Engineering & Foundry Co., Pittsburgh, has rejoined the latter company as a member of the roll and steel castings sales department. Mr. Brison for many years was at the Lincoln works of the United company, where he served successively as draftsman, assistant designer and assistant superintendent of the roll shop.

W. M. Levett resigned recently as president of Continental Casting Co., Middletown, Conn.

Henry L. Erlewine, president and general manager, Marion Machine, Foundry & Supply Co., Marion, Ind., recently was elected president of the city planning commission, Marion.

E. H. Cornelius, president, Oklahoma Steel Castings Co., Tulsa, Okla., has been elected president of the Associated Industries of Oklahoma.

O. H. Schriver, for the past 10 years general manager, Imperial Foundry Co., Knoxville, Tenn., has been elected vice president and general manager, Knoxville Foundry & Machine Co., Knoxville.

J. E. Lawton has been placed in charge of the steel and alloy roll sales department, Ohio Steel Foundry Co., Lima, O. He previously was with the Wheeling Mold & Foundry Co., Wheeling, W. Va., now a division of the Continental Roll & Steel Foundry Co., East Chicago, Ind.

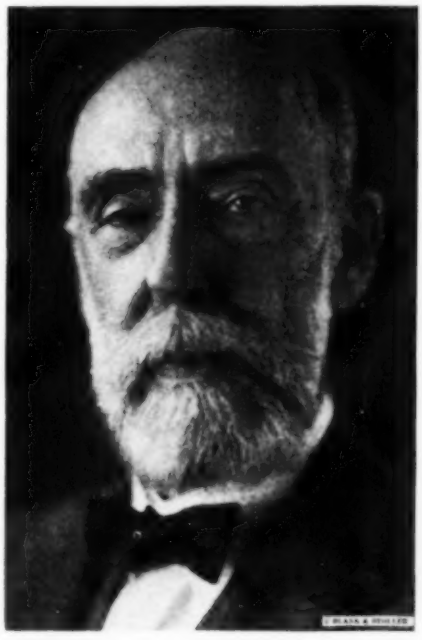
L. W. Stevens, superintendent, Veeder-Root Inc., Hartford, Conn., manufacturer of die castings, has been appointed general manager of both Hartford and Bristol, Conn., plants. **H. L. Spaunberg,** factory manager at Bristol, has been named chief engineer. Engineering facilities will be concentrated at Hartford.

Harold S. Falk, vice-president and works manager of the Falk Corp., Milwaukee, has been appointed civilian aide of the Secretary of War for the Wisconsin area. He succeeds the late Wheeler P. Bloodgood. Mr. Falk has been chairman of the Wisconsin Association of the Citizens Military Training Camps for three years.

R. L. Richwood has been made general superintendent of the Cincinnati plant, Worthington Pump & Machinery Corp., New York. **A. V. Saharoff** was made works engineer at Cincinnati, and **J. C. Russell,** production manager. **Michael Riesner** will have charge of the design and development of new and improved products.

Carl L. Spangenberg has been appointed general manager, Titus Foundry, Coldwater, Mich. **D. L. Prouty,** formerly associated with the General Electric Co., Dearborn, Mich., has been appointed office manager of the same company. **Lucius Titus** and **Walter Titus** will not be identified with the foundry actively but will retain their interest in the company.

H. A. Lomax, recently appointed general manager, Wheeling Mold & Foundry Co., Wheeling, W. Va., has been elected vice president of that



William H. Hulick

company and the Duquesne Steel Foundry Co., Coraopolis, Pa. and has been appointed manager of roll sales of the Wheeling Mold & Foundry and Duquesne Steel Foundry divisions of the Continental Roll & Steel Foundry Co. **David Wyman,** general superintendent of the Wheeling Mold & Foundry division, has been appointed general manager.

W. Hubert Beal, formerly vice president and general manager, Lycoming Mfg. Co., Williamsport, Pa., has been elected president to succeed John H. McCormick, who resigned recently. Mr. Beal has been in the sales department of the Lycoming company for the past 12 years. **Frank M. Bender,** assistant general manager, has been appointed vice president. He will continue as assistant general manager. Mr. Bender has been with the company for 18 years starting in the drafting room. He was promoted to chief engineer and finally assistant general manager.

Wm. H. Hulick Presented with Loving Cup

William H. Hulick, who retired recently after 41 year's service from the position of vice president, Warren Foundry & Pipe Corp., Phillipsburg, N. J., was guest of honor and recipient of a loving cup from members of the organization at a dinner in the Elk's club, Phillipsburg, Jan. 15. Mr. Hulick was born in Easton, Pa., March 3, 1853, a son of the late Derrick Hulick. He attended Lafayette college as a member of the class of 1873 in civil engineering. He served as a member of the Easton school board from 1879 to 1882 and was a member of the Easton town council from 1877 to 1888. During the same period he was a member of the Pennsylvania legislature. Always an ardent baseball fan he was instrumental in gaining a foothold for the sport in Easton in 1874.

His father was one of the founders of the Warren Foundry & Machine Co., and also helped to organize the Thomas Iron Co., Hokendauqua, Pa.

In tracing the progress of the firm now known as the Warren Foundry & Pipe Corp., John C. Tirrel, general foreman recalled that when Mr. Hulick became vice president, the plant had a daily capacity of 180 tons. At present the daily capacity is 350 tons. Forty years ago railroad and other facilities were decidedly meager. Horses and mules were employed to shift the cars.

The loving cup filled with roses was presented by Alfred Haley, chairman of the committee of arrangement. Other members of the committee included John C. Tirrell, W. H. Luck and A. L. Reiley. Out of town guests included George W. Taylor and John Benjamin of the New York sales department and L. R. Dohn, Wilsonborough.

Ralph E. Blazo, has been appointed manager, coke department, O. Jackson Meyer, Inc., 1447 Broad Street, Station building, Philadelphia. Mr. Blazo for some years was associated with Rogers, Brown & Co. in Boston and Philadelphia. Later he became secretary of Reed, Fears & Miller, and recently was with Hickman, Williams & Co., Philadelphia.

OBITUARY

John A. Cave, secretary and assistant treasurer, Brown & Sharpe Mfg. Co., Providence, R. I., died recently.

Henry J. Brisk, foreman in the cleaning, finishing and annealing department, American Steel Foundries, East St. Louis, Ill., died recently.

James G. Patten, president since 1925 of Metals Protection Corp., Indianapolis, died recently. Locating in Kokomo, Ind., in 1909, he became manager and secretary of Globe Stove & Range Co. He aided Elwood Haynes in organizing the Haynes Stellite Co., Kokomo, Ind., of which he later became secretary. He next founded the Udylite Process Co., of which he was president when he sold out to General Motors Corp.

Frank H. Brooks, former president and director of the E. & T. Fairbanks Scale Co., died at his home in Newton Highlands, Mass. Feb. 7. Mr. Brooks was born 62 years ago and started with the Fairbanks company in 1886 as a bookkeeper. In 1897 he became a member of the board of directors and in 1910 assumed the chairmanship of the executive committee of the board. He served as president from 1912 until his retirement from active participation in the business in 1917.

James Clark Brainard, secretary, Johnston & Jennings Co., Cleveland, died Feb. 7 at Mt. Clemens, Mich. Mr. Brainard was born at Gates Mills, O., in Oct. 1863. He became associated with the Johnston & Jennings Co. at the time of its incorporation in 1894 and served as secretary of the company from 1918 until his death. He was a former vice president of the Cleveland chamber of commerce and was a member of numerous civic and fraternal organizations. Mr. Brainard was well known throughout the foundry industry.

Frank I. Pearce, 86, last survivor of the original group which founded the Link-Belt Machinery Co., predecessor of the Link-Belt Co., Chicago, died Jan. 30, in Hollywood, Calif. He was one of the pioneers in the science of materials handling and power transmission equipment. Mr. Pearce had been a resident of Chicago for 58 years and was superintendent of Excelsior Iron Works there when he joined with William D. Ewart and Edward A. Turner in the formation of the Link-Belt Machinery Co., predecessor of the present company.

Abstract Fatigue Data

A bulletin consisting of 31 pages and containing abstracts of articles on fatigue of metals under repeated stress which have appeared in the technical press from July 1, 1929 to June 30, 1930 has been published recently by the American Society for Testing Materials. The bulletin contains 77 abstracts relating to ferrous and nonferrous metals in the wrought and cast conditions.

Foundry Association Directory

American Foundrymen's Association

President, N. K. B. Patch, Lumen Bearing Co., Buffalo; executive secretary-treasurer, C. E. Hoyt, 222 West Adams street, Chicago; technical secretary, R. E. Kennedy, 222 West Adams street, Chicago. Annual meeting, Stevens hotel, Chicago, May 4-7, 1931.

Associated Brass Founders of New England

President, George W. Thornburg, Crescent Park Brass Foundry, Waltham, Mass.; secretary, H. H. Klein, 310 Congress street, Boston. Meeting the fourth Wednesday of each month at the Engineers' club, Boston.

The Buffalo Foundrymen

President, J. McArthur, Washington Iron Works; secretary, W. J. Wark, E. J. Woodison Co., 140 Chandler street. Meetings each month at club rooms, 140 Chandler street.

Central Illinois Foundrymen's Club

President, H. M. Hire, Hire Foundry Co., Peoria, Ill.; secretary, Franklin Whitehead, The Meadows Mfg. Co., Bloomington, Ill.

Chicago Foundrymen's Club

President, L. E. Gilmore, Crane Co., Chicago; secretary, Albert N. Wallin, S. Obermayer Co., 2563 West Eighteenth street. Meetings first Thursday in each month at the City club, 315 Plymouth court.

Connecticut Foundrymen's Association

President, Carl S. Neumann, Union Mfg. Co., New Britain, Conn.; secretary, Charles S. Parker, Charles Parker Co., Meriden, Conn. Meetings are on second Friday of each month in various parts of the state.

Connecticut Nonferrous Foundrymen's Association

President, C. H. Blanchard, Reading Steel Casting Co., Pratt & Cady division, Hartford, Conn.; secretary, C. D. Elliott, Wilcox, Crittenden Co. Inc., Middletown, Conn. Meetings held the second Monday of each month at place to be named. Recent meetings have been held at Hotel Garde, New Haven, Conn.

Detroit Foundrymen's Association

President, James L. Mahon, American Car & Foundry Co.; secretary, William J. Muhlitner, Great Lakes Foundry Sand Co., 2100 Penobscot building, Detroit. Meetings third Thursday in each month, except December, June, July and August at Ft. Shelby Hotel.

East Bay Foundrymen's Association

Secretary, O. R. Moller, Electric Steel Foundry Co. Inc., 1328 Second street, Berkeley, Calif.

Electric Steel Founders' Research Group

Director, R. A. Bull, Central Office, 541 Diversey Parkway, Chicago.

Gray Iron Institute

President, B. H. Johnson, Florence Pipe Foundry & Machine Co., Florence, N. J.; manager, Arthur J. Tuscany, Terminal Tower building, Cleveland.

Malleable Iron Research Institute

President, R. R. Fauntleroy, Moline Malleable Iron Co., St. Charles, Ill.; secretary, Robert E. Belt, Union Trust building, Cleveland.

Metropolitan Brass Founders' Association

President, William Ember, Jefferson Brass Foundry, 62 Delevan street, Brooklyn, N. Y.; secretary, William E. Paulson, Thomas Paulson & Son Inc., 97 Second avenue, Brooklyn, N. Y. Meeting second Wednesday in each month at the Building Trades club, 2 Park avenue.

Newark Foundrymen's Association

President, W. H. Mantz Atlas Foundry Co., Irvington, N. J.; secretary, G. W. Hannay, Barnett Foundry & Machine Co., Irvington, N. J. Meeting called by president. Scheduled meeting dates: March 25; May 27.

New England Foundrymen's Association

President, Luther J. Anthony, Glenwood Range Co., Taunton, Mass.; secretary, Fred F. Stockwell, 205 Broadway, Cambridgeport, Mass. Meetings held the second Wednesday of each month excepting July and August at the Engineers club, 2 Commonwealth avenue, Boston. Outings usually are held in the months mentioned.

Ohio Foundries Association Inc.

President, A. H. Kramer, Advance Foundry Co., Dayton, O.; secretary, Robert Hoierman, 418 Penton building, Cleveland.

Pacific Coast Founders Association

President, Charles J. P. Hoehn, Enterprise Foundry Co., 2902 Nineteenth street, San Francisco; manager, S. M. Truitt, 55 New Montgomery street, San Francisco.

Philadelphia Foundrymen's Association

President, C. F. Hopkins, Ajax Metal Co., Philadelphia; secretary, Earl Sparks, 1623 Sansom street, Philadelphia. Meetings the second Wednesday of each month at the Manufacturers' club.

Pittsburgh Foundrymen's Association

President, W. E. Troutman, Duquesne Steel Foundry Co., Pittsburgh; secretary-treasurer, William J. Brant, Wm. J. Brant, Bessemer building, Pittsburgh. Meetings on the third Monday of the month, except in July and August at Fort Pitt hotel.

Quad-City Foundrymen's Association

President, R. L. Eichman, Bettendorf Co., Bettendorf, Ia.; secretary-treasurer, Stanley Brah. Meetings the third Monday of each month, the meeting place being rotated between Moline, Rock Island and Davenport.

St. Louis District Foundrymen's Club

President, Horace R. Culling, Carondelet Foundry Co., St. Louis; secretary-treasurer, Leo J. Filstead, John C. Kupferle Foundry Co., St. Louis. Meetings the fourth Thursday of the month at 6:30 p. m., at the American Annex hotel, Sixth and Market streets, St. Louis.

Southern Metal Trades Association

President, John S. Schofield, J. S. Schofield's Sons Co., Macon, Ga.; secretary, W. E. Dunn Jr., Flatiron building, Atlanta, Ga.

Steel Castings Development Bureau

Research Director, George Batty, 500 Stock Exchange building, Philadelphia.

Steel Founders' Society of America

President, W. H. Worrilow, Lebanon Steel Foundry, Lebanon, Pa.; managing director, G. P. Rogers, Graybar building, New York.

Tri-City Technical Council

Chairman, C. F. Scherer, Davenport Machine & Foundry Co., Davenport, Iowa; secretary, E. C. Xander, assistant secretary, Tri-City Manufacturers association, Moline, Ill. Combined meetings held only one or two times a year on call.

Tri-State Foundrymen's Association

President, William Hoppenjanz, The Star Foundry Co., 221 Main avenue, Covington, Ky.; secretary, C. C. Erhart, Chris Erhart Foundry Co., Cincinnati. Meetings the second Thursday of each month at the Cincinnati club, Eighth and Race streets.

Twin City Foundrymen's Association

President, William J. Snyker, St. Paul Foundry Co., St. Paul; secretary-treasurer, C. E. Langdon, 3849 Lyndale avenue, south, Minneapolis. Meeting third Wednesday of each month at Athletic club.

Washington Foundrymen's Club

President, J. W. Orphan, Lake Union Foundry Co., 1703 Westlake avenue, Seattle; secretary, Edward C. Gustin, The Prescott Co., 1 West Lander street, Seattle. Meetings second and fourth Tuesdays of each month at the Elks Temple, Fourth avenue and Spring street.

Western Foundrymen's Association

President, H. T. Hornsby, Joplin, Mo.; secretary, E. L. Graham, Acme Foundry & Machine Co., Coffeyville, Kans.

Wisconsin Gray Iron Foundry Group

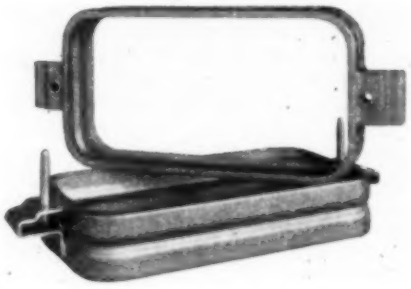
Secretary, W. F. Bornfleth, Cutler-Hammer Inc., Foundry Division, Milwaukee. Meetings on second Wednesday of each month at Hotel Schroeder, Milwaukee.

Philadelphia Founders Hear Lecture

The manufacture of steel, from iron ore to the finished product, was the subject of an illustrated address by G. A. Richardson, technical lecturer, Bethlehem Steel Co., Bethlehem, Pa., before members of the Philadelphia Foundrymen's association, at the Manufacturers club, Philadelphia, Feb. 11. Mr. McDonald, chemist, Bethlehem Steel Co., gave a short talk on alloy pig iron.

Makes All Steel Flask

Black, Sivalls & Bryson Mfg. Co., Kansas City, Mo., recently has placed on the market a new type all steel flask. The flask is equipped with re-



Removable, Case-hardened Bushings Are Provided

movable case hardened bushings, an oval bushing in one end to prevent sticking, specially designed pin to prevent incorrect closing of the molds and steel handles. The flask is designed to be light in weight. The accompanying illustration shows the cope and drag sections of the flask as well as the construction.

Subsidiaries Formed

Ajax Electric Furnace Corp., Philadelphia, has been formed to take over the manufacture and sale of the submerged resistor type induction furnaces formerly manufactured by the Ajax-Wyatt division of the Ajax Metal Co., Philadelphia. The new company will occupy a recently constructed building on Frankford avenue, Philadelphia, near the main plant of the Ajax Metal Co. Officers of the Ajax Electric Furnace Corp. are as follows: G. H. Clamer, president and general manager; James R. Wyatt, vice president in charge of manufacturing and development; Henry Gieseke, secretary; and E. Allen Ginkinger, treasurer. Mr. Gieseke also will be in charge of sales and Mr. Ginkinger will have charge of finance and accounting.

The Ajax company also has organized another subsidiary which will be known as the Ajax Electric Co. Inc. The company has been organized to develop and sell electric resistance heating equipment. The Electric Resistance Furnace Co., a subsidiary of the Electric Furnace Co. Ltd., London, England, has developed a line of resistance heating equipment which the new company intends to sell in the United States. Those companies have been associated with the Ajax Metal Co. and the Ajax Electrothermic Corp. for many years, being European agents for their products. The Electric Resistance Furnace Co. will be associated with the Ajax company in the new project. Officers of the new company are as follows: G. H. Clamer, president; William Adam Jr., vice president; John E. Haig, secretary; and E. Allen Ginkinger, treasurer.

Pittsburgh Foundrymen Continue Discussion

The Pittsburgh Foundrymen's association, at its regular monthly meeting Feb. 16, continued the discussion of the cupola operation recommendations prepared by the committee of the American Foundrymen's association, commenced at the preceding meeting. Practically the entire session was devoted to the consideration of the subject of cupola blast.

After considerable discussion, it was recommended that the proposed wording of the committee's report be amended to state that the volume of air required per ton of iron melted varies with the temperature and barometric pressure. This would be in addition to the variables of rate of melting, coke ratio and quality of coke already mentioned in the committee recommendation. It was pointed out that a nominal figure of 30,000 cubic feet of air, accepted as a general value for the volume required to melt a ton of iron, will not be suitable under varying temperatures and in localities of unusual barometric pressures.

Dr. Edward E. Marbaker, vice president, Industrial Research & Engineering Co., Pittsburgh, and member of the American Foundrymen's association committee on cupola operation, was leader of the discussion.

Meeting Is Devoted to Industrial Education

The committee on industrial education, National Founders association, Chicago, held a regional meeting Feb. 11 at the Copley-Plaza hotel, Boston, under the auspices of the New England Foundrymen's association. Henry S. Chafee, Builders Iron Foundry, Providence, R. I., acted as chairman. Dr. Harry Myers, consulting industrial engineer, Dayton, O., opened the meeting with an address on "Progress, People and Prosperity." The afternoon session was devoted to a discussion of the six laws of good work and the six principles of foremanship to which Dr. Myers referred in his talk. Following the discussion which lasted until 3 o'clock, A. D. Lynch, personnel manager, Ohio Brass Co., Mansfield, O., spoke on "Making the Shop Safe." L. W. Olson, factory manager, Ohio Brass Co., Mansfield, also addressed the meeting on "Management's Opportunity and Responsibility."

Air Entrance Is of New Design

Propellair Inc., 17 South High street, Columbus, O., recently has placed on the market a new type ventilating fan which is claimed to have an extremely high efficiency. The

Fan Is of the Airplane Propeller Type

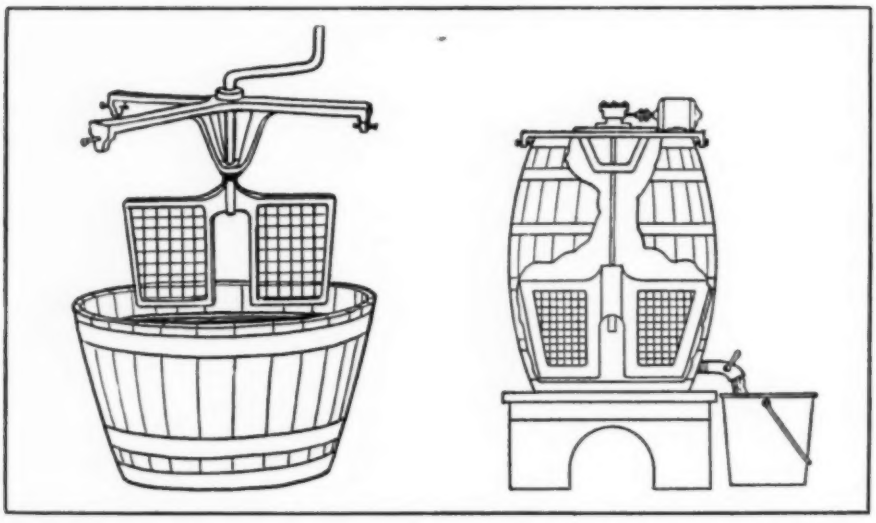
machine, which was designed by Prof. A. I. Brown, mechanical engineering laboratory, Ohio State university, Columbus, O., is of the airplane propeller type. The air entrance is curved and it is claimed that the efficiency and capacity of the fan are increased materially by that design. The accompanying illustration shows one of the new fans.

Detroit Group Meets

The regular monthly meeting of the Detroit Foundrymen's association was held Feb. 19 at the Norton Palmer hotel, Windsor, Ont. Harry W. Dietert, U. S. Radiator Corp., Detroit, gave a practical talk on "Foundry Sand Losses." The address was illustrated with lantern slides showing casting defects. He also spoke on the classification of those defects and explained the cause as well as the methods used to determine the cause and how to correct them. Jesse D. Stoddard, Detroit Testing Laboratory, official representative of the Detroit Foundrymen's association at the Birmingham regional meeting of the American Foundrymen's association, submitted a report of that meeting in which he stated that the Southern gathering was a fine success.

Mixer Is Operated by Motor or Hand

J. S. McCormick Co., Pittsburgh, has introduced a mechanism for mixing blacking and paste in the foundry. The mixing mechanism is built either to operate in a full sized or a half barrel. It consists essentially of two cross pieces at right angles to each other which are fastened to the circumference of the barrel by set screws and a yoke under the frame which assists in holding the shaft to which the paddles are attached in position. The mixer is made in two types, one is hand and the other motor operated. The latter type is built especially for attachment to full sized barrels where quantities of blacking and paste are required. The power mixer is equipped with a roller bearing head and cast aluminum screen. When the paddle or screen is turned to mix a batch, the materials pass through the screen as it whirls. The accompanying illustration shows the two types. A spigot is placed in the side of the barrel at a low point to draw off the mixture.



The Batch Is Mixed Thoroughly by Passing Through the Aluminum Screen. One Type Is Hand Operated and the Other Motor Driven

High Speed Friction Saw Removes Risers

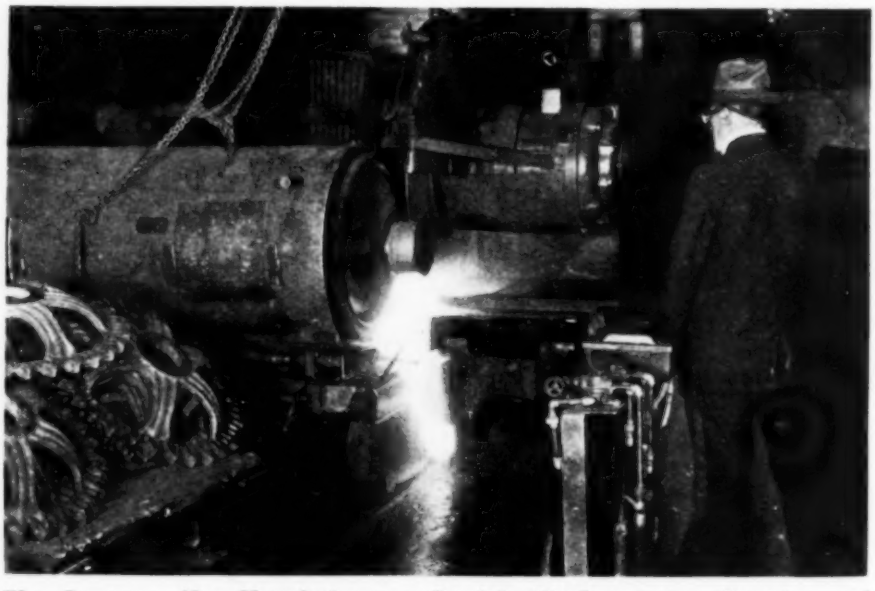
Joseph T. Ryerson & Son Inc., Continental Illinois Bank building, Chicago, has adapted a high speed friction saw, used for cutting beams, angles, channels, etc., for the removal of risers from steel castings. The accompanying illustration shows one of the machines in operation in the Harrison Steel Castings Co., Attica, Ind.

The apparatus consists of a heavy cast iron box base on which the carriage is mounted. The carriage operates on rollers horizontally. Rollers are equipped with roller bearings mounted on eccentric pins to provide for adjustment. The protecting hood is made of sheet metal and is bolted to the carriage. Blades are of special soft steel, balanced, hollow ground and hobbed on the edge, and are cooled by jets of water under pressure directed against the cutting edge.

The blade is mounted directly on the armature shaft of a practically fully enclosed motor which has an alloy steel shaft provided with a double row of large sized ball bearings. Size No. 1 is arranged for hand feed only but size No. 2, although standard equipment includes hand feed, may be equipped with hydraulic feed if desired.

Power feed for the smaller types of machines is applied through a complete unit consisting of a hydraulic cylinder, piston and a motor driven pump. The feed is operated by a 4-way valve which controls the speed and direction of travel of the carriage. The larger types, Nos. 3, 3½, 4, 4½, and 5, are equipped with a special electro-hydraulic feeding device, consisting of a cylinder and piston connected to the base of the machine and under side of the carriage respectively; a small motor driving a gear pump; a suitable tank; and a pressure relief and 4-way, controlling valves.

The machines are available for any current or voltage. Sizes Nos. 1 and 2 are equipped with 30 and 40 horsepower motors and Nos. 3 and 4 with 50 and 75 horsepower motors respectively. Saw blade diameters are 46, 48, 52 and 56 inches for the machines respectively.



The Company Also Manufactures a Special Attachment for Clamping and Rotating the Casting

Develops Pulverizer

Stedman's Foundry & Machine Works, Aurora, Ind., recently has developed a line of swing and ring hammer grinding, crushing and pulverizing equipment. The line consists of three types made in 25 sizes ranging from 5 to 250 horsepower. Type A machine, a general purpose unit, is applicable to the foundry industry and is designed for fine and semifine grinding and pulverizing.

Materials are reduced by a 2-stage reduction method. Shattering is done in suspension by that method and finish grinding is accomplished after gravity has been overcome. The secondary reduction takes place between the face of an adjustable grinding plate and hammer tips. It is claimed that feature makes possible large capacities, a uniformly finished product and low maintenance costs.

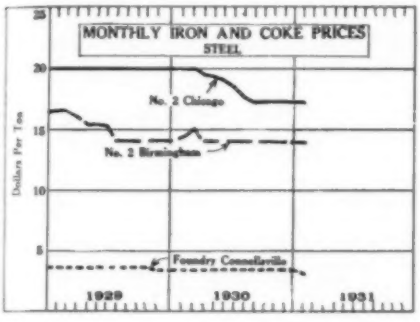
In addition to the 2-stage reduction method, pulverizing and grinding mills made by the Stedman company are claimed to have the following features: built in metal trap; exceptionally heavy, renewable, wearing plates; adjustable grinding plate; self-aligning, antifriction bearings; easy accessibility for repairs.

Trade Trends in Tabloid

INDUSTRIAL activity generally continues to show a slow but gradual improvement. This condition has been reflected in increases in the operating schedules of certain foundries, especially those specializing in castings for the automotive industry. If the present trend of business continues during the next two or three months, industrial leaders feel that confidence, so lacking during the past few months, again will be restored.

—T—T—

The last week in February found automobile production at almost 51,-



000 units, compared with 45,000 in the last week of January. February, the shortest month of the year, probably witnessed a total production of 200,000 cars against 186,000 in January. The most assuring feature of the situation in that industry is the absence of schedule curtailment, while at the same time numerous companies are increasing their output.

—T—T—

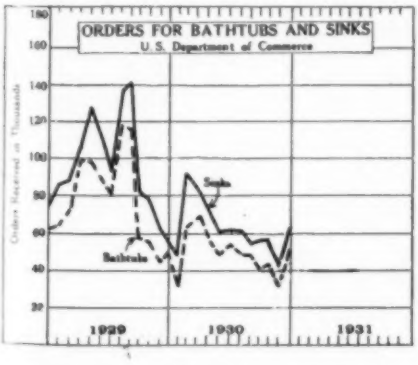
A number of jobbing shops and stove manufacturers in the St. Louis district, which have been idle since late in 1930, have resumed operations.

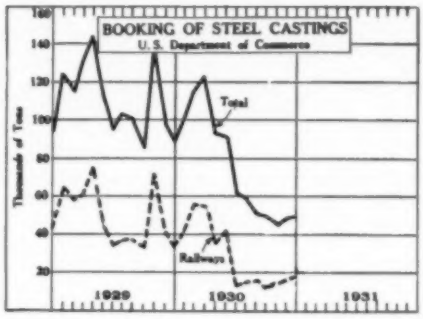
—T—T—

Building awards, repeating the usual trend, were lower in January than in December, the January total amounting to $227,956,400 compared with $249,935,500 in the preceding month. However, the F. W. Dodge Corp. reports promising indication for renewed building activity in the near future.

—T—T—

Freight car buying is exceptionally





light with approximately 1650 cars actively pending. Railroads placed orders for only 100 cars in January, the lowest monthly total since 1919. Not much improvement is expected until the surplus cars now in storage in railroad yards are called into service.

—T—T—

Steady demand from consuming districts has depleted stocks of cast iron pipe in the yards of Birmingham pipe makers and has resulted in an increase in operating schedules of pipe foundries in that district. Demand for that product also is increasing.

—T—T—

Improvement in pig iron demand is reported from Boston, Philadelphia, Cincinnati, St. Louis, Birmingham, and Toronto districts.

—T—T—

Aluminum foundries in the Chicago district had the most promising sched-

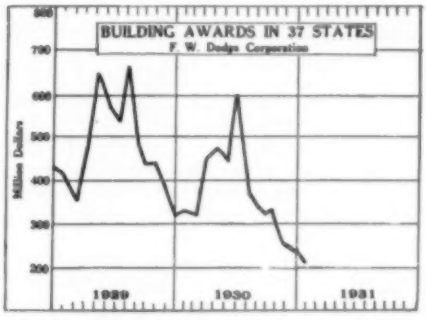
RAW MATERIAL PRICES
Feb. 19, 1931

Iron	
No. 2 foundry, Valley	$16.50 to 17.00
No. 2 Southern, Birmingham	14.00
No. 2 foundry, Chicago	17.50
No. 2 foundry, Buffalo	17.50
Basic, Valley	16.50 to 17.00
Basic, Buffalo	17.00
Malleable, Chicago	17.50
Malleable, Buffalo	18.00
Coke	
Connellsville beehive coke	$3.25 to 4.85
Wise county beehive coke	4.25 to 5.00
Detroit by-product coke	8.50
Scrap	
Heavy melting steel, Valley	$12.00 to 12.50
Heavy melting steel, Pitts.	12.50 to 13.00
Heavy melting steel, Chicago	9.75 to 10.25
Stove plate, Buffalo	9.50 to 10.00
Stove plate, Chicago	7.75 to 8.25
No. 1 cast, New York	8.00 to 8.50
No. 1 cast, Chicago	9.50 to 10.00
No. 1 cast, Philadelphia	13.00
No. 1 cast, Pittsburgh	12.50 to 13.00
No. 1 cast, Birmingham	10.00 to 11.00
Car wheels, iron, Pittsburgh	13.50 to 14.00
Car wheels, iron, Chicago	10.75 to 11.25
Railroad malleable, Chicago	12.00 to 12.50
Agricultural mal., Chicago	10.50 to 11.00
Malleable, Buffalo	12.00 to 12.50
Nonferrous Metals	**Cents per pound**
Casting, copper, refinery	10.00
Straits, tin	27.00 to 27.12½
Aluminum, No. 12, producers	22.00
Aluminum, No. 12, remelt	11.00 to 12.00
Lead, New York	4.60
Antimony, New York	7.00 to 7.10
Nickel, electro	35.00
Zinc, East St. Louis, Ill.	3.95 to 4.00

ules of business at the middle of February. Orders for automotive and miscellaneous castings put those plants on a four to five day operating basis. Foundry operations generally remain slightly under 40 per cent. Malleable plants in western Michigan also have benefited from recent automobile business. Railroad equipment and farm implement business continues to lag.

—T—T—

Car loadings for the week of Feb. 7 totaled 719,053, a decline of 228 compared with the preceding week. Movement of freight for the first five weeks



of 1931 declined 20 per cent over the corresponding period in 1930.

—T—T—

Unfilled orders for brass and bronze ingots and billets declined 1600 tons in January compared with 3306 tons the preceding month. Orders on hand on Feb. 1 totaled 23,415 tons compared with 25,015 tons on Jan. 1 and 9630 tons on Feb. 1, 1930.

—T—T—

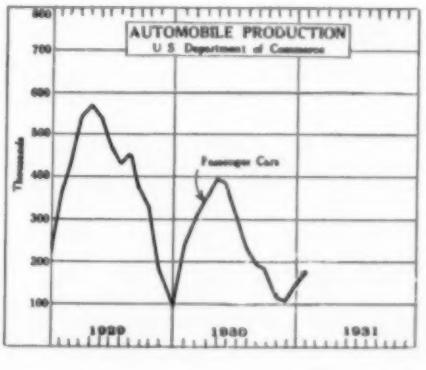
A slight improvement has been noted recently in the market for machine tools.

—T—T—

Unfilled orders for railroad locomotives at the end of January called for only 91 units, the smallest total reported for several years. Unfilled orders at the end of December totaled 104 and on Jan. 31, 1930, orders for 591 units were on the books.

—T—T—

Brass foundry operations in the New York district are averaging approximately 40 per cent.



What the Foundries Are Doing

Reflecting the Activities of Gray Iron, Malleable, Steel and Brass Shops

Foundry of the New Departure Mfg. Co., Bristol, Conn., has been discontinued.

Pennsylvania Lawn Mower Works, has moved its plant from 1615 North Twenty-third street, Philadelphia, to its plant at Primos, Pa.

Terminal Brass & Iron Foundry, Brooklyn, has been incorporated with $10,000 capital by N. Bardach, Beekman street, New York.

Angeles Foundry Co., Port Angeles, Wash., has been incorporated with $10,000 capital by Lewis & Church, attorneys.

Olcott Foundry & Machine Works is being operated at 431 South Third Street, Paducah, Ky. by Fred W. Olcott. This company specializes in gray iron castings.

Van Wert Foundry Co., Van Wert, O., recently began operations at practically full capacity. The plant has been operating part time with a reduced force for several months.

Bucyrus-Erie Co., South Milwaukee, Wis., W. W. Coleman president, will install new equipment and machinery and construct a 2-story addition for pattern storage.

American Coolair Corp., 3604 Mayflower street, Jacksonville, Fla., is operating a foundry for brass, aluminum and cast iron products and for the manufacture of fans.

Portland Foundry Co., Portland, Conn., which operated around 50 per cent of capacity during 1930, has experienced a pick-up of business since Jan. 1 and now is operating at full capacity.

Long & Allstatter Co., Hamilton, O., has acquired the plant of the Advance Foundry Co., Hamilton, O. Long & Allstatter Co. will operate this plant with the same organization. R. A. Leeds is manager.

Mascot Stove & Mfg. Co., Twenty-fifth and Chestnut streets, Chattanooga, Tenn., recently has completed an addition to its plant. The new construction replaces that part of the plant damaged by fire last November.

Hubbard Street Foundry Co. Inc., Indianapolis, has been incorporated to carry on a foundry and metal manufacturing business. Burrell Wright, Edward J. Boleman and Herman L. McCrary are the incorporators.

Biggs Aluminum Foundry, 1222 Greenland avenue, Nashville, Tenn., recently has been organized by Jesse T. Biggs and E. R. Biggs, to manufacture aluminum castings. Jesse T. Biggs is manager.

Waukesha Pattern Works, Waukesha, Wis., will build a 2-story pattern works building, approximately 50 x 100 feet. Frank D. Chase Inc., 720 North Michigan avenue, Chicago, has the general contract.

Hedges-Walsh-Weidner Co., Chattanooga, Tenn., will continue to operate under that name although the company now is controlled by the International Combustion Engineering Corp., New York. The company is operating at about 30 per cent capacity at present.

Advance Rumely Corp., La Porte, Ind., has been formed by merger of the Advance Rumely Co. and the Indiana Farm Machinery Corp., La Porte, Ind. Formal approval to the consolidation has been given by the directors of both companies.

The main office of the Coatsville Boiler Works has been moved from its Coatsville, Pa. plant to its Middletown, Pa. plant. The company recently purchased the Middletown plant of the Standard Steel Car Co., Pittsburgh.

Duriron Co., Dayton, O., has placed its new steel foundry in operation. The company specializes in alloys resistant to corrosion by chemicals.

Shelton Foundry & Machine Works, 121 North First Street, Paducah, Ky., which has been operating a machine shop for the past sx months, expects to start operation of its foundry within the next 30 days. Howard E. Shelton is proprietor.

Ability Pattern Works, 425 South Fifteenth avenue, Maywood, Chicago, Ill., has been incorporated to manufacture patterns and do miscellaneous machine work. Axel, Hilma A. and Elmer A. Lundgren are the incorporators.

Smith Steel Casting Co., Anderson, Ind., has been organized with $25,000 capital by K. Smith and C. Million, president and vice president respectively. The new company will be located in buildings formerly occupied by the La Velle Foundry Co., on Jefferson street, Anderson.

Eureka Foundry Co., 1161 Bellevue avenue, Detroit, Mich., recently was organized and started operations. The company maintains a jobbing shop for the production of gray iron castings. Owners are Harry Elliott, Stewart Elliott, and Roy Elliott. Charles H. Smith is foundry superintendent.

Jeffrey Mfg. Co., Columbus, O., Robert W. Gillispie president and general manager, has construction under way of a pattern building. Cost, with equipment, will be $90,000. Structure will be 90 x 150 feet. Contract is held by Middle States Construction Co., 1183 Essex avenue.

Toronto Brass Machine & Foundry Co., 74 Market street, Toronto, Ont., is having plans prepared by J. A. Thatcher, architect, 37 Cowan avenue, for its new 1-story plant on Leslie street near Eastern avenue. Structure will be 40 x 100 feet. Equipment will be purchased after construction bids have been called.

Meehanite Research Institute of America Inc., Chattanooga, Tenn., has been incorporated by G. H. Meehan, Frank M. Robbins, H. Bond, O. Smalley and R. J. Goldie. The purpose of the organization is to promote good will, scientific research and general improvement in the manufacture and sale of metal castings made by a patented process.

General Alloys Co., 405 West First street, Boston, has bought the plant equipment of the Cleveland Alloys Co., Cleveland, manufacturer of corrosion-resistant alloys. The equipment, including a 1-ton electric furnace, has been shipped to the company's new plant at Champaign, Ill., where a new 2-ton and a 500-pound furnace already are installed.

Highway Trailer Co., Edgerton, Wis., manufacturer of automobile trailers, is negotiating with the city council for lease or purchase of a foundry owned by the city of Stoughton, Wis. Proposed plans are for the expansion of the unit for the production of castings. Expenditures will amount to $25,000 or $30,000. J. W. Menhall is president of the Highway company.

Foundry department of the Massey-Harris Co., Batavia, N. Y., will be running at capacity within a few weeks, according to William S. Milne, general superintendent. The company plans to produce all of its own gray iron and malleable castings instead of purchasing from the outside. Some new equipment will be installed. Operations up to this time have been on a three-day a week basis.

Trade Publications

ELECTRIC MOTORS—A series of loose-leaf pages from the Century Electric Co., St. Louis, give specifications including power, speed, weight, price, and electrical characteristics of squirrel-cage induction motors ranging from 2 to 200 horsepower.

UNIT HEATERS—A catalog recently issued by the Buffalo Forge Co., Buffalo, illustrates and describes industrial heating and ventilating equipment of various types. Engineering specifications are given with information on choosing the right type and size for any particular job.

BUCKETS—A recent catalog from the Blaw-Knox Co., Pittsburgh, covers a line of buckets including 600 sizes up to one cubic yard capacity. The equipment is adapted to excavating, material handling, and general contracting requirements. Typical uses are well illustrated and the design features of the equipment shown. A reference chart is included giving detailed specifications of the buckets.

BUCKETS — Single-line buckets suitable for use with cranes, hoists, derricks, etc., are described in an illustrated bulletin from the Blaw-Knox Co., Pittsburgh. Drawings, specifications, and illustrations of typical uses are included with notes on the operation and construction. Ingot tongs, foundry buckets, and dumping buckets also are described. The foundry bucket is of the hook-on, single-line type adaptable to material handling and cleaning up.